THE ENGINEER

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Lloyd's Register of Shipping

LLOYD'S REGISTER OF SHIPPING has issued its 1951 edition of the Appendix to Lloyd's Register Book. The statistical tables include a list giving the gross tonnage of the principal merchant fleets of the world and indicating the change in the totals compared with 1949. The world total at 84,583,000 tons is 2,012,000 tons more than the previous year and the largest increases are shown for Norway, 539,000 tons; Panama, 345,000 tons, and Japan, 307,000 tons. Compared with 1939 the largest increases are noted for the United States of America, namely, 16,152,000 tons, which includes the 14,000,000 tons reserve fleet; Panama, Canada, Argentina and Norway, while the fleets of Germany, Japan, Italy and Greece have decreased. The preponderance of ships of 6000 to 8000 tons, shown in the five to ten-year-old group, is a result of war-time building, but much of this tonnage is not in commission. Of ships built since the war the largest amount of tonnage is in the size group 8000 to 10,000 tons. There is also an increase in the numbers of ships between 10,000 and 20,000 tons from 496 in 1939 to 950 in 1949, and 1032 in 1950, of which 734 are oil tankers. The reverse applies to ships of 20,000 tons and upwards; the numbers have decreased from eighty-two in 1939 to fifty-eight in 1950, the number of such vessels being built in the United Kingdom being thirty-nine in the current year, as compared with forty-two in 1939. Excluding the U.S.A. reserve fleet, one-quarter of the world's effective tonnage is twenty-five years old. Motorships form 25 per cent of the world tonnage but the percentage in various countries shows wide variations. In Norway, motorships amount to 71 per cent of the tonnage; in Great Britain and Northern Ireland the figure is 34 per cent, whereas for U.S.A. it is 4 per cent. Oil tankers over 1000 tons gross now amount to 16,866,000 tons gross, an increase of 1,042,000 tons since 1949.

Transport in Scotland

IN the course of a tour of inspection of railway, road haulage and road passenger installations in the various parts of Scotland last week, Lord Hurcomb said that the organisation developed by the British Transport Commission provided that the needs of the travelling public in Scotland and of Scottish traders should be considered and dealt with on the spot by men in direct touch with local conditions. British Road Services had consolidated their twenty-seven Scottish operating groups, which incorporated 184 depots and nearly 4000 vehicles. Originally permits were given to about 1000 independent hauliers in Scotland to enable them to carry on in the long-distance field, and all but about eighty of these permits would be continued for another three years with or without some modification in their conditions. The scheme for the integration of road and rail services was now taking practical shape, said Lord Hurcomb, and an important new parcels service, recently started between London and Glasgow, should greatly benefit traders and the public. Cases and packages which would normally have been trunked by road between depots were now being handled by rail in demountable containers, to save about one-third of the time hitherto taken. The creation of a unified railway system for Scotland, Lord Hurcomb stated, had yielded considerable economies, which had made it possible to improve services. Rearrangements of freight train working had produced an annual saving of nearly £100,000. The Clyde steamer services, despite the fact that they were being run at a considerable loss, were to be improved. The Executive had been authorised to place tenders for four new passenger ferry boats, with accommodation for 500 passengers each, and for three general-purpose passenger and cargo boats. Scottish road transport was finally dealt with by Lord Hurcomb, who pointed out that, despite a serious fall in net revenue in 1950, the bus group had maintained efficient services and was constantly seeking new economies.

The Motor Vehicle Industry and Sheet Steel Supplies

AT a meeting of the National Advisory Council for the Motor Manufacturing Industry, held at the Ministry of Supply on January 31st, the repercussions on the supply of vehicles to the home market, resulting from the reduction of the supply of steel sheet to the motor industry, was discussed. The reduction of steel sheet supplies was announced on January 10th and was stated by the Ministry to be an outcome of a fall in imports and the need to provide for defence demands. Under the new arrangement the motor vehicle industry is expected to receive in the first quarter of this year about 85 per cent of the deliveries made in the last quarter of 1950. It is hoped that supplies will continue at the same level in the second quarter of the year and that they should improve towards the end of the year. The total supply in 1951 is, however, bound to be less than in 1950. On December 4th the Minister of Supply announced in the House of Commons that the home quotas in 1951 for cars and commercial vehicles would be 110,000 and 95,000 (including 8500 public service vehicles), respectively, but that the position would be reviewed from time to time. The statement went on to say that it would not be possible to estimate with any assurance the likely output of vehicles in 1951 but as far as could be seen the output of cars and commercial vehicles might fall to 460,000 and 230,000, respectively, compared with approximately 520,000 and 260,000 in 1950. The Advisory Council was informed at the meeting on January 31st that the Minister had decided that the fall in output must be shared equally between the home and the export markets. He asked that home deliveries should be limited in 1951 to 80,000 cars and 80,000 commercial vehicles (including 8000 public service vehicles). The Society of Motor Manufacturers and Traders says that the reduced production must react unfavourably on costs despite efforts made to hold them down.

Repair of Albert Bridge, London

THE condition of the carriageway and footway paving on Albert bridge, London, has been under observation for a number of years, and maintenance work during that period was confined to the minimum considered essential for public safety. Since March, 1950, however, while Battersea bridge was closed for repairs, more traffic used Albert bridge, and the London County Council has decided that large-scale repairs are now essential. These will include the renewal of the decking and of any defective supporting boards and timber bearers and the repair and possible replacement of any corroded steel cross girders. The cost will probably be of the order of £40,000, and the bridge will be closed for several months. Battersea bridge was recently reopened and the repairs to Albert bridge will be started at an early date. If the work cannot be completed before the opening of the Festival of Britain it may be possible to postpone some of the repairs until the Festival is over. The L.C.C. states that every endeavour will be made to keep the bridge open during the Festival.

Opencast Coal Production

IT was stated in the course of the coal debate in the House of Commons last Thursday that the opencast programme was to be extended. This statement has been followed by an announcement by the Ministry of Fuel and Power which points out that, in view of the country's increasing coal requirements, a high rate of opencast production must be maintained during the next five years at least. The announcement goes on to say that the country's remaining accessible coal outcrops are not unlimited in extent and for the most part have yet to be prospected. Moreover, the consequent interference with food production and the amenities of the countryside, which the Government regretted, must continue to be kept to the minimum. With more intensive prospecting it is hoped, however, that 50 million tons of opencast coal can be produced during the next five years. It is considered that fully this quantity—and more, if possible—will be needed, unless the production of deep-mined coal exceeds all present expectations. In giving effect to this policy the Government will, it is stated, continue to attach the highest importance to securing fully satisfactory standards of land restoration so as to minimise the consequent loss of food production. Everything practicable will be done still further to improve the technique of restoration and the Government hopes to consult the National Farmers' Union and Country Landowners' Association about how that can best be done; similarly, every practicable measure will continue to be taken to prevent damage to the amenities of the countryside.

Mineral Working and Local Planning Authorities

A MEMORANDUM, "The Control of Mineral Working," has been prepared by the Ministry of Local Government and Planning, to explain the various Acts and Regulations on the subject in an easily understood form, and give guidance to local planning authorities on how they should exercise their powers of control. In attempting to put the control of mineral working into its proper perspective, the memorandum does not in any way suggest that planning control provides a formula whereby mineral working can be carried out without interference with agriculture or damage to the appearance of the countryside. It aims at giving guidance to local planning authorities on the problems of balancing the claims of agriculture and other important uses of land against the need to develop the country's mineral resources. Five guiding principles listed in the memorandum for the guidance of local authorities are as follows: mineral deposits which are likely to be needed should not be unnecessarily sterilised by surface building; the necessary right, in suitable land, should be made available to mineral undertakers—if necessary through the use of compulsory powers; the working of minerals should be prevented or limited where it would involve unjustified interference with agriculture or other surface uses; proper regard should be paid to the appearance of the countryside and, wherever practicable, land used for mineral working should not be left derelict when operations have been completed. The memorandum is published by H.M. Stationery Office, price 2s. net.

The Development of a High-Speed, Multi-point Indicator

By JOHN C. MORRISON, B.Sc., Ph.D., M.I.Mech.E.*

THE function of the indicator described in this article is to give diagrams of extremely rapid variations of pressure in pipes and cylinders when such variations are periodic. The purpose for which it was originally devised by the author was to record the pressures in the exhaust pipe of a petrol engine running at speeds up to 5000 r.p.m., and the results of some of this work are given in two papers to the Institution of Automobile Engineers.† The variations of pressure in this case are in the nature of sound waves, and the maximum rate of variation that has been recorded is 1 lb per square inch in 0·0002 sec. The frequency of the small waves shown in Fig. 6 is 280 per second, and still higher frequencies can be obtained. The maximum pressure above atmospheric for which the indicator has been used is 13 lb per square inch. Higher pressures than this can be taken, but tests for limiting pressures have not been made.

Three models on the same principle, but differing somewhat in detail, have been made, and it is the second model which will now be described.

Referring to the diagrammatic sketch, Fig. 1, the hardened steel rotor 1 is carried on a central brass shaft 2, fixed by the flange to a bracket 3. A brass face plate 4, whose angular position is determined by the locking plate 5, bears on the face of the rotor, to which it is pressed by the rubber washer and screwed rod 6. The gas pressure which is being recorded enters by the central hole

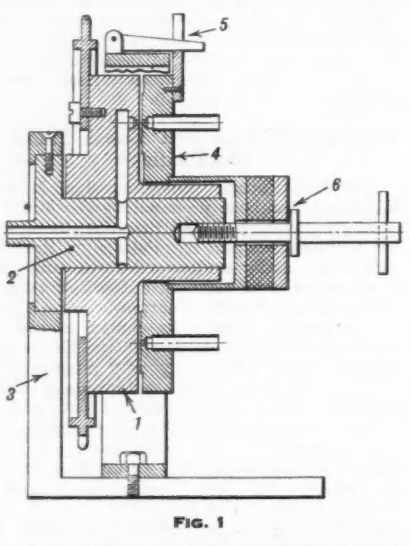

FIG. 1

in the shaft and passes by a circumferential groove to a radial hole in the rotor and thence by a $^{5}/_{64}$in diameter hole to the rotor face. Here it coincides at intervals with similar holes in the brass plate, and a connection is made by rubber tubes to manometers arranged side by side in a frame. When the indicator is connected to the exhaust pipe of a four-cycle petrol engine and is driven at half engine speed, the pressure variation is periodic and each time the hole in the rotor face coincides with any given hole in the face plate the pressure transmitted is the same and is registered by the manometer. The pressure at a number of points in the cycle can thus be obtained. The method of noting the manometer readings is to place a piece of tracing paper on a celluloid sheet in front of the manometers and mark the position of the mercury in each tube on the paper. The general arrangement of the first indicator is shown in Fig. 2.

A question of some importance in this design is the number of points in the cycle at which pressures should be taken in order to give reasonably accurate curves.

The first indicator had eighteen manometers which gave points every 20 deg. of rotor revolution—that is, every 40 deg. of crankshaft revolution—and by turning the face plate through 5 deg. three times pressures were obtained for every 10 deg. of crankshaft revolution. This was found to be ample for even very rapid changes of pressure.

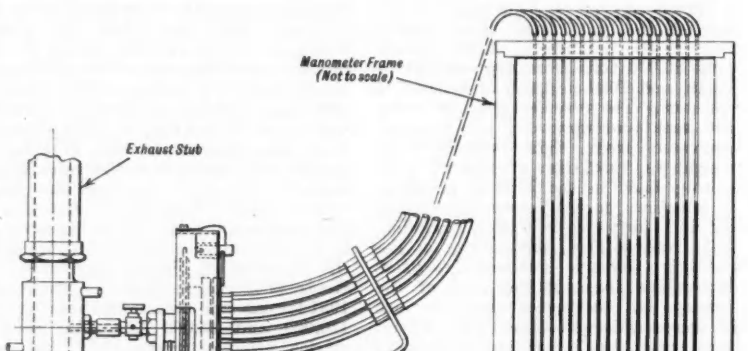

FIG. 2

It required four markings for each manometer, and a diagram could be made in 2 min.

The author then thought that points every 15 deg. might be enough, and the second model was made with twenty-four manometers so that one movement of the face plate was sufficient. The pitch of the tubes on the face plate had to be large enough to accommodate rubber tubes over the ¼in diameter brass tubes, and the P.C.D. was made $3\frac{3}{16}$in, giving a pitch of 0·417in. The gas seal between the face plate and rotor and along the rotor bearing appeared to be perfect for the usual pressures which varied from −6 lb to +10 lb per square inch. The seal depends on the presence of an oil film, so the oil supply must be plentiful, yet not excessive, as it tends to get into the rubber tubes, and these should have an upward slope to return any oil which may have entered. Ordinary machine shop oil was used at first and was found to be much too thick and gave a high friction torque and blocked the small holes in the face plate. The oil ultimately used was very thin and had a Redwood viscosity of about 120 seconds at 70 deg. Fah. Even with suitable lubrication a fair amount of heat was generated and the face plate had to be water cooled. A ¼in diameter copper tube soldered round the circumference served for this purpose.

It may be remarked here that doubts have been expressed as to the ability of this type of indicator to record pressures lower than 1 lb or 2 lb per square inch. It is quite true that continued over-lubrication makes such readings incorrect, but the error is usually very obvious, and the author did not find any inconsistency in low-pressure readings when the lubrication was suitable.

The force required to keep the working faces gastight was small when the gas pressure was fluctuating rapidly above and below atmospheric, as it does in an exhaust pipe, but in some of the tests in which the pressure was always positive the force had to be increased considerably and the oil had to be supplied under pressure.

An essential feature in the use of this indicator is that the engine must be run at a constant speed while the diagram is being taken. This is not an easy condition to satisfy, and the author got over the difficulty by introducing a plate valve between the face plate and the manometers so that when the desired speed had been reached one motion of this valve shut off the manometers and maintained the pressures till they could be marked on the tracing paper.

The first indicator had been given a test with constant gas pressure up to 4000 r.p.m. and was found to function correctly; but this was no guarantee that it would perform equally well with rapidly varying pressures, and so the second indicator was tested in the following way. A small air compressor, 2in bore by 3in stroke, was made, having a large clearance volume to keep the pressure low. There were no valves, and the piston simply compressed the air and let it expand again. An ordinary steam engine indicator was connected to the cylinder and driven from a crosshead moving in a similar manner to the piston, but at right angles to it and giving a diagram 90 deg. out of phase, which improved the accuracy at the ends of the stroke. The multi-point indicator was also connected to the cylinder and was chain driven from the crankshaft. The compressor was run at a constant speed and diagrams were obtained from both indicators. Care was taken to have both indicators phased correctly with the piston motion. The steam engine indicator diagram was measured at many points with a reading microscope and plotted to the same scale as the other indicator diagram, along with the theoretical diagram. The latter was calculated on the assumption that the compression was adiabatic and that there was no leak past the piston. Several tests were made at speeds

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† "Proceedings" 1933, Vol. XXVII, p. 614, and "Proceedings" 1940, Vol. XXXIV, p. 211.

up to 350 r.p.m., and they all showed the characteristics seen in Fig. 3, namely, that the steam engine indicator had a considerable lag, that the multi-point indicator agreed with the theoretical for the first part of the compression and thereafter gave lower pressures than the theoretical, which can be explained by the fact that at this low speed there was some leakage past the piston (which had no rings), and there was time

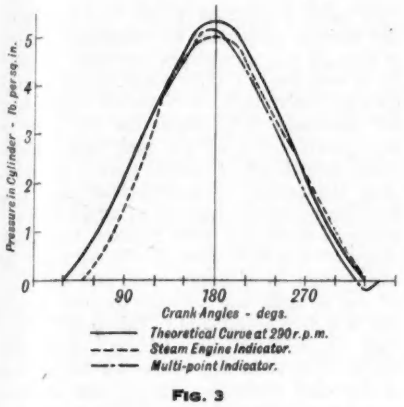


FIG. 3

for some heat exchange, so that the compression was not quite adiabatic. At really high speeds these two losses should be negligible, so tests were made at increasing speeds, and it was found that the losses were progressively reduced till at 1600 r.p.m. and upwards the actual and theoretical diagrams coincided exactly (Fig. 4).

It is well known that a long passage from a cylinder to an indicator may give faulty readings, and the effect of lengthening the connection was now tried. In order to compare diagrams with short and long connections it was necessary to obtain both on the same run and without loss of time. A three-way cock was put on the indicator so that the gas could either go straight through or be deflected round a longer way. The length of the latter passage was increased until the diagram showed a distinct change of shape. Fig. 5 gives the comparison of a length of 2in with that of 14½in at 1600 r.p.m. It is clear that a wave motion develops in

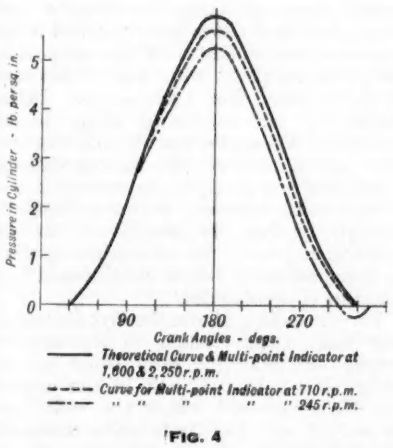


FIG. 4

the longer passage and gives a slight increase in the maximum pressure. At still higher speeds this was more pronounced. At the speeds used there was no change for lengths below 8in, which should be regarded as a limiting figure. These tests proved that the indicator was satisfactory for rates of pressure variation caused by piston motion, but it was necessary to test the indicator with the much more rapid variations of wave motion.

The compressor was now altered to make it produce wave motion similar to that in an exhaust pipe. A port was cut in the cylinder in such a position that the piston uncovered it near the end of the out stroke, and a pipe 1in bore and nearly 3ft long was attached to a cover over the port. The connection to the indicator was made from this cover. A pipe from a compressed air supply line was connected to the end of the cylinder. When the piston moved out and uncovered the port the air escaped suddenly like the exhaust of a two-stroke engine, and a pressure wave was produced in the pipe. A fishtail was put on the open end of the pipe to damp out the waves and avoid the complication of residual waves. An easier way of making waves was to dispense with the compressed air and put a non-return valve in the cylinder end so that as the piston moved in it pushed the air out and caused a partial vacuum on the outstroke. When the port was uncovered a negative wave was produced in the pipe. Tests were made using both these methods.

The steam engine indicator would have been useless at the speeds now employed, and there was no suitable indicator available with which to make comparisons. It was easy to see that the diagrams were reasonable and that the periods of the waves were what would be expected from the given length

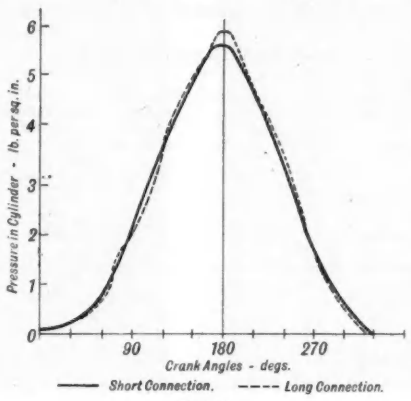


FIG. 5

of pipe, but calculating the actual pressures would have been very difficult, especially as the coefficient of discharge of the port was not known. However, the fact that this type of indicator can give accurate diagrams of wave motion was shown by Professor G. F. Mucklow in his paper on "Exhaust Pipe Effects in a Single-Cylinder, Four-Stroke Engine," "Proceedings" of the Institution of Mechanical Engineers, Vol. 143, page 109, 1940. The indicator used in this case was different in design from that of the author's, but worked on exactly the same principle. Professor Mucklow calculated the forms of waves set up in exhaust pipes and found that there was good agreement between these forms and the diagrams obtained from his indicator. It is permissible, therefore, to conclude that the indicator can give correct values of rapidly varying pressures, and the author found the indicator to be satisfactory until he used it on the exhaust of an engine which had exceptionally quick-lift valves when a hitherto negligible source of error became serious. This was the independent vibration of the column of gas in the passage from the manifold to the rotor face, which was caused by the extremely sudden rise of pressure in the manifold. The amplitude of this vibration was great enough to be very troublesome, but a cure was effected by connecting a small resonator to the pipe where it joined the indicator.

Experiments were carried out on the compressor to see the effect of length of connection when wave motion was being recorded. A comparison of long and short lengths is given in Fig. 6. The general effect of increasing the length is to cause a lag in the pressure change followed by a surge which gives an increase in the maximum pressure change, and thereafter the vibration of the gas column can be seen superimposed on the main wave and continuing after the latter has stopped. The period of this vibra-

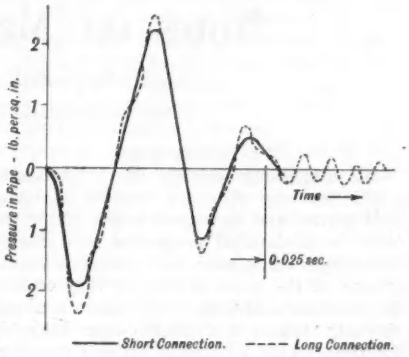


FIG. 6

tion can be got from the diagram and checks with that calculated for the length of the passage.

A resonator of the minimum effective volume was now attached to the three-way cock on the indicator and diagrams were taken with both short and long connections with the resonator in operation. The diagrams were similar, the one from the longer connection being displaced on the time base and showing a time lag corresponding to that which was calculated for the extra length of pipe. The measurement of such a short time on the diagram could not be considered accurate, but it could be said that the time lag was never greater than that calculated. It was clear, however, that a long passage was to be avoided, and a third indicator was made in which the length was reduced to a minimum. It was decided to revert to eighteen manometers in place of twenty-four and to reduce the P.C.D. of the holes in the face plate to 2⅜in. The rotor 1 was fixed to a central spindle which rotated in ball bearings some distance from the rotor so that the chain drive was out of the way

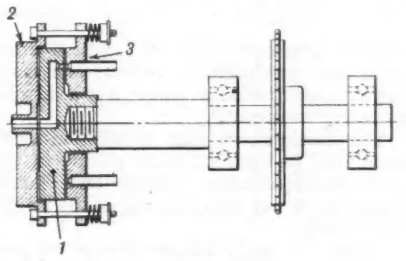


FIG. 7

(Fig. 7), and allowed the rotor to go close to the place from which the pressure was to be taken. The gas connection was made to the brass plate 2 bearing on the end of the rotor. This plate and the face plate 3 were drawn together by spring-loaded bolts to give the necessary pressure on the rotor. When this indicator was attached to the compressor the minimum distance from the offtake to the rotor face was 2⅞in. It was not found possible to make this short column vibrate, and the distance was then increased till the vibration began at an increase of 2in. Even with a water-cooled attachment on an exhaust pipe the net length of the passage

can be kept down to 3½in, so that there should be no trouble with vibrations when the pressure waves are of normal intensity. In the case of shock waves which may have an almost instantaneous rise in pressure, even this short length might be caused to vibrate and another design would have to be sought.

The indicator was also used to give the pressure inside the petrol engine cylinder during the exhaust and suction strokes. A small poppet valve in the cylinder head was timed to shut off the connection to the indicator during the compression and working strokes.

The indicators were made in the James Watt Engineering Laboratories, the University of Glasgow, where all the work done with them was carried out.

Notes on Magnesium Alloys

By F. A. FOX, D.Sc., M.Sc., F.I.M.

No. II—(*Continued from page 150, February 2nd*)

Heat-Treatment

The magnesium casting alloys containing aluminium and zinc are capable of being heat-treated and undergo a marked improvement in mechanical properties as a result. For alloys containing only small amounts of zinc, of the order of 0·5 per cent or less, the solution-treatment temperature is about 410 deg. Cent., and twenty-four hours is the time which is usually applied commercially, although with alloys containing aluminium much above 8 per cent., solution is not complete under these conditions. Table III indicates the improvement produced in two magnesium-aluminium-zinc alloys by solution-treatment and by solution-treatment and precipitation, and in one magnesium-zinc-zirconium alloy by a simple reheating treatment.

Table III—*The Effect of Heat-Treatment on the Mechanical Properties of Three Casting Alloys*

Nominal composition, per cent	D.T.D. specification	Elektron designation	Condition	0·1 per cent proof stress, tons/in²	Ultimate stress, tons/in²	Per cent elongation on 2in
Mg+8 Al +0·4 Zn +0·3 Mn	59B	A8	As cast	5·3	10·5	3·0
Mg+8 Al +0·4 Zn +0·3 Mn	289B	A8	Solution treated... ...	5·1	17·0	12·5
Mg+9·5 Al +0·4 Zn +0·3 Mn	136B	AZ91	As cast	5·0	9·6	1·5
Mg+9·5 Al +0·4 Zn +0·3 Mn	281B	AZ91	Solution treated... ...	5·0	17·0	9·0
Mg+9·5 Al +0·4 Zn +0·3 Mn	285A	AZ91	Solution treated and precipitation treated	7·5	17·0	1·5
Mg+4·5 Zn +0·7 Zr	711	Z5Z	As cast	7–8·5	13–17	7–15
Mg+4·5 Zn +0·7 Zr	721	Z5Z	Heat-treated	8·5–10·5	15–18	5–12

The homogeneous state of solution-treatment may be retained fairly readily in the aluminium-containing alloys, and liquid quenching is not essential, unless the article is very large.

There is a slight volume change on precipitation treatment in the aluminium-containing alloys. This, however, is not great, and amounts to only about 0·0005in per inch for the high aluminium alloys.

Apart from the new zirconium-containing alloys, on which experience is now rapidly accumulating, those alloys used for stressed parts are of the magnesium-aluminium-zinc type. Elektron A8, the 8/0·4/0·3 aluminium, zinc, manganese-containing alloy, has the following special points:—

(1) It has good as-cast properties, particularly ultimate tensile stress.

(2) It responds readily and uniformly to heat-treatment.

(3) As solution-treated it has the best elongation of all the neighbouring alloys; its ultimate tensile stress is also much improved.

Elektron AZ91, the 9·5/0·4/0·3 aluminium-zinc, manganese-containing alloy has the following special points:—

(1) It has a good proof stress as cast, though its ultimate tensile stress is not so good as for Elektron A8.

(2) Its castability is excellent, being rather superior to that of Elektron A8, and it is particularly suitable for die casting.

(3) Its freedom from microporosity is especially good.

(4) Its proof stress can be improved by 50 per cent by a solution and precipitation treatment; its ultimate tensile stress is good, but its elongation is low in the precipitated state.

(5) Its heat-treatment characteristics are not quite so good as for Elektron A8; its higher aluminium content makes it slightly more difficult to homogenise.

The two alloys are similar for corrosion resistance.

These points indicate clearly why in aircraft, for example, designers have tended to call for Elektron A8 for structural parts and Elektron AZ91 for engine parts.

The latter's good castability and freedom from microporosity make it well suited for the very complex castings demanded by engine designers, and the high proof stress that can be obtained after precipitation treatment makes it eminently desirable from the high-performance standpoint.

Elektron A8 is well fitted for structural parts which are not so complex, but where the safety margin, provided by the high elongation value obtained when it is solution-treated, makes it particularly valuable.

It can be seen from the foregoing that from the point of view of mechanical properties there is little point in solution-treating Elektron AZ91, since an outstanding elongation figure (which is the particular feature of the solution-treated state) is not obtained with this alloy in this condition. Similarly, there is little point in precipitation-treating Elektron A8, since the proof stress of this alloy in this state is below that for precipitation-treated Elektron AZ91.

Fatigue Properties

A most important point in considering the fatigue properties of magnesium alloys is that of the number of reversals applied. It is well known that while steels usually give an asymptotic S–N curve after 10×10^6 reversals, light alloys do not give an asymptotic curve at all, and their fatigue values are therefore limited period or endurance strengths. If applications are being handled where the number of applications of stress is mounting very rapidly, the whole shape of the S–N curve, as far as it can be ascertained, is of importance, and the angle of the straight-line part of the curve with the N axis is significant. This point is now well appreciated in testing aluminium alloys, and tests are often run on a basis of 500×10^6 reversals: in the case of some aluminium alloys this procedure is particularly necessary, owing to the fact that even at 100×10^6 reversals the angle of the straight-line part of the curve with the N axis is quite considerable.

These long-time tests are troublesome and require high-speed testing if they are to be done in a reasonable time, but are none the less necessary. In aircraft engine assemblies, for example, vibration is always present, and the frequency of stress reversal in a light alloy part may be anything from four up to ten or more times the engine speed. This may mean that in service the rate of stress reversal is as much as 25,000 per minute; few flying hours are required to give a part a "long-time" test under these conditions. For this reason tests based on 10×10^6 reversals are of limited interest only.

The S–N Wöhler test curve for Elektron AZ855 shows that this material possesses a Wöhler figure of about ±9 tons per square inch on a basis of 50×10^6 reversals. It has been suggested that a reason why the S–N curves of the Elektron alloys become more nearly asymptotic than do those of most aluminium base alloys is to be found in the constitutional condition of the magnesium alloys as compared with that of the high strength aluminium base alloys. Unlike duralumin, the magnesium alloys do not spontaneously age-harden at room temperature, and it may be that the conventional duralumin type precipitation hardening is of a type which essentially improves the static strength, whereas the instability of the solid solution may cause the strengthening effect to disappear under fatigue conditions at high numbers of stress cycles.

For the casting alloys, the Wöhler fatigue test bears some relation to the ultimate tensile strength, the ratio being of the order of 0·3 to 0·4, and in the case of the higher strength alloys, the ratio may be as high as 0·45. As for other materials, the fatigue properties do not appear to be related to other static mechanical properties, such as proof stress or elongation. It therefore follows that the precipitation heat-treating of cast alloys does not produce considerable improvement in their fatigue figures, since the effect of this heat-treatment is to improve the proof stress rather than the tensile strength. Furthermore, there seems to be a tendency for the flat portion of the S–N curve to retain a steeper angle where a

higher percentage of alloying constituent is present.

For wrought alloys, the ratio of the Wöhler strength to the tensile strength is between 0·4 and 0·5. Cold working appears to have a smaller beneficial effect on the fatigue figures than on the static properties; although the limited period fatigue test figures may be improved by such cold working, the advantage will tend to disappear as the number of reversals becomes greater. This is another important reason why, when testing magnesium alloys, a large number of reversals should be used.

An important characteristic of Elektron alloys which affects the behaviour of the alloys in fatigue is that rather nebulous quantity, damping capacity. It is known that damping capacity exerts an influence on fatigue behaviour, and that generally the fatigue performance is better the higher the damping capacity. The factors affecting damping capacity itself are not so clear, and its measurement is not easy. The quantitative application of damping capacity measurement to engineering problems is a question which still remains to be explored. It is, however, true of the Elektron alloys that the damping capacity is very high, and, in common with other materials, it is likely to increase rapidly with increasing temperature.

Although, generally speaking, work-hardening the whole piece does not appear to improve the fatigue characteristics very greatly, it has been found that local cold work on the surface of wrought Elektron components does somewhat improve their fatigue performance. This has led to suggestions for the superficial cold rolling of suitably shaped forged components, and the result has been an increase in the Wöhler figure by something of the order of 20 per cent.

High strength magnesium alloys are liable to be notch sensitive, although the newer alloys are much less so, and in highly stressed parts it is of great importance in design that changes of section should be made smoothly and gradually, and that the surface finish should be as good as possible.

Notch sensitivity can be determined in respect of all types of stress and is not necessarily confined to fatigue determinations. A considerable difficulty in assessing the tendency to notch sensitivity is the fact that the stress concentration effect of a given notch is by no means certain. It is usual to determine the stress concentration of a given notch by photo-elastic or soap film methods. These, however, depend on the behaviour of the material in its elastic range, and do not take account of plastic behaviour, during which considerable changes in the stress concentration may set in. For this reason, it may happen that a large stress concentration factor as photo-elastically determined may be of negligible importance in practice, where very small amounts of deformation can neutralise its effects.

In the fatigue testing of Elektron, as with other materials, the super-imposition of a compression load increases the safe stress range. Wöhler figures for wrought aluminium containing Elektron alloys are in the range of 9 tons per square inch, and those of cast Elektron aluminium-containing alloys are in the range of 5 tons per square inch. The "push-pull" (Haigh) fatigue figures are approximately 0·5 to 0·6 times these quantities. The repeated tensile fatigue strength is equal to about 0·65 times the Wöhler figure for casting alloys, and is approximately equal to the Wöhler figure for the wrought alloys.

The mechanical properties of most magnesium alloys of the usual composition range begin to decrease fairly rapidly above 150 deg. Cent., and for this reason they are not used for applications involving high temperatures. Recent development work on the zirconium-containing alloys has, however, shown that the one containing 0·7 per cent zirconium and 3 per cent cerium (mischmetall) has excellent creep properties, comparable with those of aluminium-base alloys, at temperatures up to 200 deg. Cent. Above this temperature the properties, even for this alloy, are not particularly good.

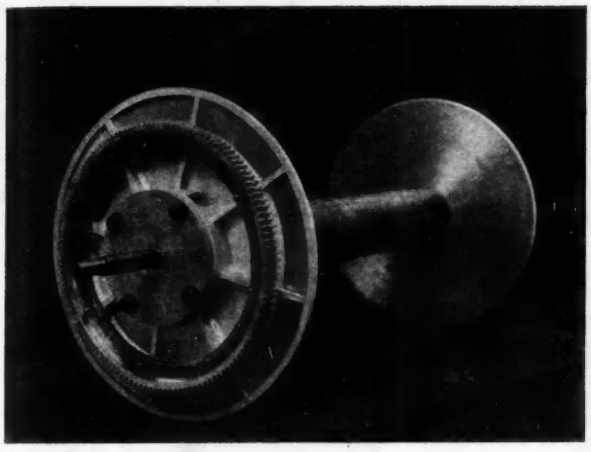


FIG. 1—WEAVER'S BEAM

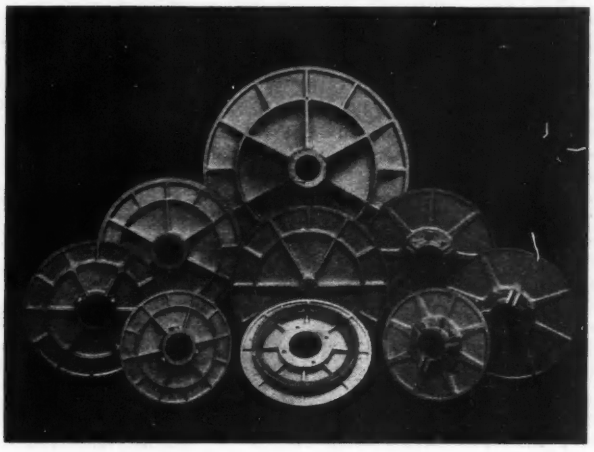


FIG. 2—GROUP OF CAST ELEKTRON WEAVER'S BEAM FLANGES

SURFACE PROTECTION

The two standard protective treatments used for the magnesium - aluminium - zinc alloys are the acid chromate dip and the half-hour boiling bath immersion known as the R.A.E. treatment. Of these, the former removes a small amount of metal (about 0·0005in per surface) but is rapid in operation —of the order of one minute; the latter removes no metal, but is longer in operation. These are covered by DTD Specification No. 911A. Special baths have been developed for the zirconium-containing alloys, though the treatment of DTD 911A can also be used.

Neither of these protective treatments is as effective as the anodic protection of aluminium alloys, and the films formed confer no mechanical protection.

These coats should be regarded as paint bases and as a preliminary in a protection scheme for magnesium alloys rather than as true protective treatments in themselves. This is an important point, since people familiar with the powerful protection given by the aluminium anodising treatment are apt to think that "protected" magnesium alloys will withstand any corrosive conditions. If the corrosive conditions to which the "protected" but unpainted pieces are exposed are not severe, then the protection will have been of benefit; if the conditions are severe, then "protected" pieces may actually behave worse than unprotected metal. The reason for this is that when magnesium or magnesium base alloys are corroded by sodium chloride solution (the standard corrosion testing medium), a large proportion of the insoluble corrosion product remains firmly attached to the metal surface; when specimens which have received a protective treatment are corroded in this way, the corrosion product is loose and non-adherent. It is thus to be expected that untreated metal will corrode more and more slowly as the film of corrosion product spreads and thickens; with treated metal, unrestricted and continuous corrosion will take place at discontinuities in the protective film, causing severe pitting and gradual undermining of the film. It is apparent that the protected specimens will begin to corrode in the manner of unprotected pieces as soon as the protective film has been completely undermined.

Much work has been done to evolve initial treatments for magnesium alloys which give improved protection. Anodic treatments of many kinds; treatments with fluorides, phosphates, tungstates, molybdates, steam treatments and autoclave treatments in caustic solutions have all been proposed, but none has given such outstanding results as to make a change from the present simple schemes worth while.

Even though the initial treatment is not so protective as that for aluminium alloys, the completed scheme, dip and primer and finishing coats, gives good corrosion resistance. This has been shown conclusively by service records over a long period.

The corrosion of magnesium alloys, even when exposed unprotected to atmospheric attack, is slower than for ordinary mild steel, which also requires protecting.

Many attempts have been made to plate magnesium alloys, but so far these have been unsuccessful as far as improving the corrosion resistance goes. A nickel film can be put on by means of a fluoborate bath, but its value is decorative and not utilitarian. The difficulty has been to obtain, first, a metallic coat which will adhere, and secondly, to produce a sufficiently non-porous plating. If the plating

is porous to any great extent or should a scratch or a cut edge expose both metals together to corrosive attack, the galvanic action is so severe that the magnesium is rapidly eaten away.

This indicates how necessary it is to insulate magnesium alloys from dissimilar metals when constructing assemblies. It has been found that the aluminium-base alloy MG5 produces a less harmful effect on magnesium than does duralumin, but insulation is again desirable. Insulation with pure aluminium foil or with

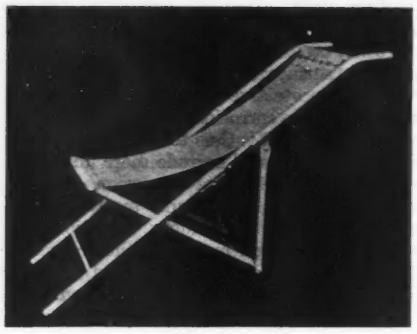


FIG. 3—ELEKTRON AMBULANCE CARRYING CHAIR

PVC strip has proved very effective. Zinc chromate paste is also a useful insulator.

Attempts have been made to "clad" magnesium alloy sheet; these, however, have proved to be difficult and not worth while, for the same reasons which operate against plating magnesium.

Magnesium alloys have in this country been free from that bugbear associated with many other non-ferrous alloys—intercrystalline corrosion; however, some experience has shown that heavily worked Elektron AZM may tend to intercrystalline cracking if heavily stressed.

Magnesium alloys can be machined astonishingly freely without lubrication and with low power absorption. Their machineability greatly exceeds, in fact, that of any other metallic materials, and cutting speeds of

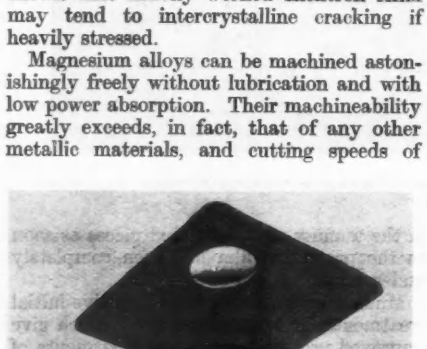


FIG. 4—CAST ELEKTRON CONTROL BOX

5000ft per minute are readily attained on a lathe with a feed of 0·030in per minute and a cut of 0·150in. Normal tools can in general be used; however, best results follow from small tool faces, large relief angles, large chip spaces and small rake angles.

The fire risk is small provided that the cutting tool is kept sharp and free from burrs and that heat is not allowed to develop by friction. The inflammability of small pieces of magnesium becomes dangerously great only when the particle size is greatly reduced. Thus magnesium powder, the particle size of which is near 240 mesh, will rise in temperature only a few degrees even when wetted. However, extremely fine magnesium powder, of the order of 10^{-5}cm particle size, is pyrophoric or even explosive on exposure to air.

In commercial practice the machining of magnesium alloy components may be aided by the use of jets of compressed air to keep cutting edges cool; sintered carbide tools give better results than high-carbon or high-speed tools.

Special attention must be given to dust disposal in grinding, since suspensions of powder are ignitable by a spark. Recommended systems usually depend on the continuous removal of the dust in an air-stream and "drowning" it in a large excess of water; such a system has, in fact, been made compulsory by Factory Act regulations.

APPLICATIONS

The engineering applications of magnesium alloy are very numerous, and mainly result from its outstanding characteristics, lightness and machineability; it also finds considerable use as an alloying element for other metals, particularly aluminium. The quality of lightness leads naturally to uses in which the avoidance of inertia effects are of importance. Many highly stressed aircraft parts have been produced in large quantities with complete service success; these include engine parts, accessory drive housings, blower casings, various control column castings, and landing wheels. These latter encounter particularly arduous duty with severe and incalculable shock loading.

Magnesium alloys are beginning to be applied in jet engines, to the efficiency of which they contribute materially; here the zirconium-containing alloys find their use particularly for parts which must resist high temperatures.

Magnesium alloys are also finding increasing uses in other industries, such as in the pneumatic tool, textile machinery, electrical, office equipment, machine tool and optical equipment industries. The transmission casing for the Ferguson tractor, gearbox covers, rear-axle castings for lorries, and beer-bottle crates mainly made from magnesium alloy sheet, are typical examples. Figs. 1 to 4 illustrate some recent applications by F. A. Hughes and Co., Ltd. The first shows a weaver's beam made entirely of Elektron, except for axles, bolts and gear. The flange diameter is 20½in, and the barrel length 38in. It weighs less than half the old type of beam it replaces. A group of weaver's beam flanges is shown in Fig. 2. The ambulance carrying chair of tubular construction shown in Fig. 3 has a weight of only 12 lb as against 24 lb for the equivalent steel chair. In the last engraving there is seen a cast Elektron control box for use in the electrical trade. It has dimensions of 8½in by 8½in by 3½in, and a weight of 3 lb 2 oz.

The Testing of Motive Power Machinery*

By T. W. F. BROWN, D.Sc.

No. II—(*Continued from page 154, February 2nd*)

TESTING IN 1900

IN 1900 land and marine tests of motive power machinery could be carried out by absorbing the power in a brake. For marine work, except for examples such as the test engine, referred to later, at Durham College of Science, now King's College of Durham University, trials were mainly based on measured indicated horsepower. Brakes, however, were used frequently for tests on smaller engines, particularly diesel and gas engines. The friction brake has already been referred to, but the maximum power which could be absorbed was of the order of 400 b.h.p. at 200 r.p.m. For powers above this it was difficult to carry away the heat of friction from the brake drum.

In 1876 Reynolds had used a centrifugal pump as a brake by measuring the reaction torque on the freely mounted casing. In 1877 Froude greatly improved the arrangement by introducing the modern form of hydraulic brake.

When driving dynamos or alternators very accurate measurement of power could be carried out, such tests being normally referred to the electrical output. Accurate wattmeters were available and calibration of electrical instruments had reached high accuracy. Where the power had to be referred to the engine, excluding electrical and mechanical losses in the electrical generator, the stator of the generators was pivoted. The principle was first employed by the Rev. F. J. Smith in 1881. As built these electrical dynamometers were larger than hydraulic brakes, but were stable and easily regulated.

In 1887 the Institution of Mechanical Engineers set up a Marine Engine Trials Committee, which drew up a standard method for conducting marine engine trials. In 1888 they carried out trials in the "Meteor." In 1890 trials were reported on three further ships, "Fusi Yama," "Colchester" and "Tartar." The discussion on these reports was extremely stimulating to boiler and machinery contractors. Reports followed on the machinery of the "Iona" (1891), "Ville de Douvres" (in 1892), and a summary by Mr. (later Professor Sir) Thomas Hudson Beare appeared in 1894. These trials showed the necessity for carrying out trials under controlled conditions, which were difficult to ensure with accuracy at sea as power necessarily varies with wind and weather. Consideration of this kind led to the construction of a large quadruple-expansion steam engine designed especially for experimental work at the Durham College of Science. The arrangements were described by Professor Weighton† and are worthy of note as they probably represent the best practice in the shore testing of machinery at the time. They are also the first extensive tests designed to improve marine machinery. The boiler pressure was 210 lb per square inch, revolutions 140 per minute, vacuum 24in. The cylinder diameters could be changed by inserting liners and the engine could be worked single expansion, compound, triple or quadruple expansion. In one arrangement the cylinder diameters were 7in, 10½in, 15½in and 23in, the stroke being 18in.

The brake horsepower was measured by a Froude hydraulic dynamometer, the torque being measured by weights and a spring balance. An autographic record was taken of the extension of the spring balance during the trials, enabling the average load to be accurately determined. The total condensate was measured in two volumetric tanks with "accurately graduated floats." The main circulating water flow was determined in a weir with a graduated float to show head over the orifice. All drains were led to steam traps with receivers and calibrated gauge glasses.

Glass thermometers and Bourdon gauges were used to measure temperatures and pressures and the indicated horsepower was measured from cards taken on a "Richards" indicator.

A very important series of sea trials was

* James Watt Lecture, Greenock Philosophical Society. Abstract.

† "Trans.," N.E. Coast Inst., 1896.

carried out by the Admiralty Boiler Committee on H.M.S. "Hyacinth," "Minerva" and "Saxonia," reported in 1902.‡ Volumetric tanks were specially installed to measure the main engine condensate, with separate tanks to measure the auxiliary condensate and jacket water from the cylinders. All tanks were calibrated and fitted with water gauges. The engine powers were "indicated horsepower." The fuel was coal, which was brought from bunkers on to the stokehold floors in "skids," each skid being weighed on a spring balance. The stokehold floors were swept clean at the commencement and conclusion of each trial. Samples of coal were taken and calorific value and ultimate analysis determined. High temperatures were measured by platinum resistance thermometers made by the Cambridge Scientific Instrument Company specially for these trials. The ship's gauges measured pressures, but the note is made that thermometers were regarded as being more reliable to measure pressures than pressure gauges. A Carpenter calorimeter measured the dryness of the steam from the boilers and flue gas analyses were carried out. For their time they were the most exhaustive trials carried out at sea.

The trials carried out by Sir Charles Parsons both for turbo-generator machinery and in the "Turbinia" are now classic. For the "Turbinia" trials he developed a "spring torsional dynamometer," which he used when investigating the loss in propeller efficiency caused by cavitation in 1894–96.

A report was made to the Steam Engine Research Committee of the Institution of Mechanical Engineers in 1905. The experiments measured cylinder condensation and slide valve leakage in a small single-cylinder engine. The instrumentation was similar to that already described in other trials, and it is interesting to note that the problems of cylinder condensation and "missing quantity" investigated by Watt on his engines were still not solved.

‡ H.M.S.O. 1902. (Navy) Water Tube Boilers. Report on Trials.

Table II—*Marine Steam Turbines*

	Merchant						Naval	
Year of test	1897	1910	1921	1926	1946	1948	1931	
Ship	"Turbinia"	"Vespasian"	Vessel "C"	"King George V"	"Beaverglen"	Merchant ship	"Acheron" (destroyer)	
Speed, knots	32¾	10·7	13	—	16½	—		
Type of machinery	Three-cylinder direct drive	Two-cylinder, with single reduction gearing	Three-cylinder, double reduction (h.p. and i.p. in tandem	Three-cylinder, double reduction	Two-cylinder tandem electric transmission	Two-cylinder, double reduction gearing	Three-cylinder, single reduction gearing, twin screw	
Authority	Ewing[1]	Parsons[2]	Potts[3]	Parsons, Walker and Cook[4]	Davis[5]	—	Walker[6]	
							60 per cent power	Full power
Shaft horsepower	2,100 (approx.)	1,095	2,933	3,489	9,010	7,000	20,400	34,000
Revolutions per minute	H.p. and i.p., 2,230 L.p., 2,000	73·3	76·2	569	112	105		
Steam pressure at boiler, pounds per square inch gauge	210	145	200	520	820	455	500	
Steam temperature at boiler, deg. Fah.	Saturated	Saturated	200 superheat	815	850 Reheat to 850	850	750	
Vacuum (30in barometer), inch Hg	—	28·5	27·9	28·8	29·0	29·2	28·94	28·67
Steam rate:								
Main engines, pounds per shaft horsepower-hour	—	14·3	9·12	8·01	6·05	7·46	7·08	6·85
All purposes, pounds per shaft horsepower-hour	14½ (approx.)	14·95	10·66	9·67	6·50 (diesel generators)	— (diesel generators)	7·92	7·78
Fuel rate (all purposes), pounds per shaft horsepower-hour	—	1·66	1·15 (approx.)	1·085	0·520 (propulsion only)	0·541 (propulsion only)	0·676	0·620
Coal or oil	Coal	Coal	Coal	Coal	Oil	Oil	Oil	
Gross calorific value of fuel, B.Th.U. per pound	—	13,000 (assumed)	13,000 (assumed)	13,880	19,000	19,000	19,000	
Overall thermal efficiency, per cent	—	11·8	17·0	16·9	25·8	24·2	19·8	21·6

[1] Parsons, 1903 (Appendix), "Transactions," I.N.A.
[2] Parsons, 1910, "Transactions," I.N.A.
[3] Potts, 1923, "Transactions," N.E.C. Inst. of E. and S.
[4] Parsons, Walker and Cook, 1927, "Transactions," N.E.C. Inst. of E. and S.
[5] Davis, 1947, "Transactions," N.E.C. Inst. of E. and S.
[6] Walker, 1935, "Transactions," N.E.C. Inst. of E. and S.

Developments in Power Measurement—1950

Apart from hydraulic dynamometers which have greatly increased in sensitivity by absorb 4000 s.h.p. at between 2000 and 9000 r.p.m. They can be controlled electronically to give a number of speed-power relationships, examples being (*a*) constant torque, or (*b*) constant speed, and (*c*) torque varying as $(\text{r.p.m.})^2$, the latter being usually known as the "propeller law" characteristic. Many attempts have also been made to develop reliable and accurate torsionmeters.

Many other instruments for full-scale testing have also been developed in the period 1900–1950. Some of the most important are here briefly referred to. Many of them depend on the vast developments in electronics:

(*a*) Strain gauge equipment for the measurement of static and transient stresses in machinery parts, including vibrational stresses, is now common. The means of fastening such gauges to the parts of machinery have now been so perfected that strain gauge equipment can be used for temperatures up to 1200 deg. Fah.

(*b*) Control instruments consisting of capacitance gauges enable rotor movements and the shuttling of gear elements to be determined. Such movements can be recorded or photographed by suitable electronic circuits.

(*c*) The measurement of axial and torsional vibration originally measured mechanically by instruments of the Geiger type is now performed electronically by suitable pick-ups and cathode-ray oscillographs.

(*d*) The measurement of machinery vibration and noise is of increasing importance, particularly in turbine machinery, where revolutions of the various parts are rising in order to get smaller turbines of greater output at higher

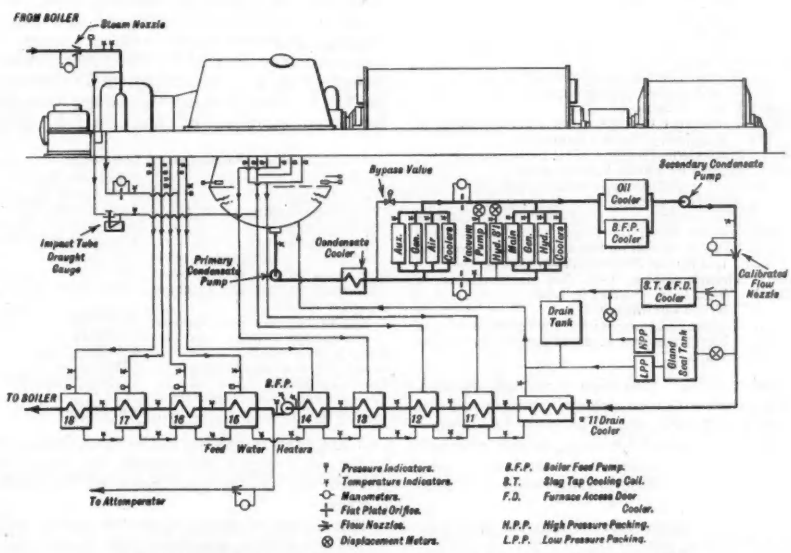


FIG. 1—DIAGRAM OF CYCLE AND LOCATION OF INSTRUMENTS

steam conditions. To measure this noise level meters and analysers are available. The development of these instruments is, however, a vast subject in itself and this brief mention must suffice.

FACILITIES FOR TESTING MACHINERY—1950

Most land motive power engines are tested when erected on site. A very full description of the testing of the Essex turbine is given in the paper by Renton and Neal, "Heat Rate Test Results of the 100,000kW Essex Turbine Generator," in the "Transactions" of the American Society of Mechanical Engineers, 1950. The points at which measurements were taken are shown in Fig. 1, and the following gives the lists of instruments used during the tests and also the test procedure.

Temperature.—All important temperatures measured with chromel P-copnic thermocouples inserted in wells; pipe-wall temperatures measured with copper-copnic thermocouples peened into pipe walls. The corresponding thermo-electromotive forces were measured with precision potentiometers, mercury-in-glass thermometers being used for condensate temperatures at generator coolers.

TABLE III—*Dates of Instruments Developed for Testing of Motive Power Machinery*

1700	Mercury-in-glass thermometers in use since early 1700's
1776–1780	Watt's steam measurements by means of change in boiler water level
1794	Watt's engine indicator
c. 1800	Coal consumption usually measured in bushels
c. 1800	Mercury manometers. Pressure gauges depending on compression of an air column
c. 1800	Mercury vacuum gauges of various types
1821	Friction brake devised by Piobert and Hardy; applied to engine testing by Prony
1821	Seebeck thermo-electric effect discovered; thermocouples not applied to engine testing for almost 100 years
1841	First mechanical torsionmeter—Morin
c. 1850	Coal consumption usually obtained by weighing; calorific values not measured, usual to use standard coal, "Welsh hand-picked"
1852	Wilson suggested calorimetric method of measuring high temperatures
1854	Hirn's torsionmeter
1854	Kennedy water meter introduced and used for measurement of boiler feed water
1854	Bourdon gauge coming into use
c. 1854	Bourdon vacuum gauge
1858	Froude's belt dynamometer
1871	Siemens invented platinum resistance thermometer—not sufficiently accurate until improved by Callendar, *c.* 1887
1877	Hydraulic brake invented by Froude
1881	Balanced electric generator first used on small scale by Rev. F. J. Smith
1888–1892	Calorific values measured in trials carried out by Marine Engines Trials Committee
1888–1892	Volumetric measuring tanks used in sea trials carried out by Marine Engines Trials Committee
Weigh tanks used:	
1902	Neptune Bank power station
1904	Westinghouse testing department
1905	King's College, London
1900–1904	Resistance thermometers used in trials of Admiralty Boiler Committee
1908	Hopkinson-Thring optical torsionmeter
1911	Amsler hydraulic torsionmeter
1920	Ford induction type torsionmeters
1924	Moullin induction type torsionmeters
1924–1931	Fuel consumption of oil engines measured on shore trials by weigh tank, and on sea trials by volumetric tank, in trials carried out by Oil Engines Trials Committee
1924–1931	Thermocouples used for measurement of high temperatures in trials of Oil Engines Trials Committee
1948	Deadweight gauges used for measurement of high pressures in some American turbine trials

Temperatures read at ten-minute intervals except for throttle temperature and maximum feed temperature which were read at five-minute intervals.

All thermocouples and thermometers calibrated before and after use.

Pressure.—(*a*) Above 25 lb per square inch absolute measured by means of deadweight gauges.

(*b*) 5 lb to 25 lb per square inch absolute. For this pressure range mercury manometers were used.

(*c*) Condenser pressures—mercury-filled absolute gauges.

N.B.—Connections for (*b*) and (*c*) maintained free of water by bleeding a small amount of air into each pipe.

Flow Rates.—(*a*) Condensate flow by calibrated nozzle. Pressure difference read on mercury manometer—at one-minute intervals.

(*b*) Condensate flows to gland-seal tank and from the h.p. turbine packings by displacement-type integrating flow meters. Flow recorded every fifteen minutes.

(*c*) Flow to attemperator by nozzle. Pressure difference by manometer containing dibromoethane (S.G.=2·17). Readings every five minutes.

(*d*) Slag-tap and boiler access door cooling flow by flow nozzle and mercury manometer.

(*e*) Flow of condensate through generator coolers by thin-plate orifices and mercury manometers.

(*f*) Leakage from second section of h.p. gland by thin-plate orifice and mercury manometer.

(*g*) Leakage from third section of h.p. gland by impact tube at pipe axis and wall static tapping. Pressure difference indicated on draft gauge.

(*h*) Water levels in hot-well and feed heaters read on calibrated sight glasses.

Procedure.—(*a*) The pipe system checked before each test for isolation of unit. Isolation ensured by inserting blind gaskets between flanges or by closing two valves in series and opening "tell-tale" drain valve between them.

(*b*) Usually possible to hold steam temperature constant to within ±10 deg. Fah. and throttle pressure to within ±10 lb per square inch. Condenser pressure adjusted by bleeding air into condenser—held within 0·01in Hg.

(*c*) The majority of tests were carried out at a valve intercept point, i.e., just prior to opening of next higher valve. Setting by opening governor until all lost motion taken up in cam-and-roller assembly of next higher valve—checked by testing force on roller with pinch bar. This method considered better than measuring valve lifts since lift measurements were affected by differential expansion.

(*d*) Duration of tests:

Those at 1½in Hg. exhaust pressure, two hours; those at other exhaust pressures, one hour.

To ensure constant conditions, load set and held steady for one hour before test period.

Brakes are used in the smaller sets which are not coupled to electrical generators.

(To be continued)

Main Line Diesel-Electric Locomotives for the Southern Region

WE have received from the Southern Region of British Railways particulars of a new main line diesel-electric locomotive which has been designed and built at the Ashford Works. This locomotive is the outcome of a decision made, towards the end of 1946, by the directors of the late Southern Railway Company to build three diesel-electric locomotives for express passenger work. Owing to various causes the scheme was delayed so that the first locomotive was completed only quite recently.

The project originated shortly before the London Midland and Scottish Railway Company also decided to build two similar locomotives. The designs made by each company were prepared independently to suit the particular requirements of each railway system, the Southern Railway locomotives being intended for passenger working only, whilst those on the London Midland and Scottish Railway were for mixed traffic working. The locomotive for the L.M.R., No. 10,000, was fully described in THE ENGINEER of December 26, 1947. In both designs the power equipment has been supplied by the English Electric Co., Ltd. and is similar in the main items, there being only small differences in the control system and in the gear ratio of the traction motors.

Main Particulars of Locomotive

Type	"1 Co–Co 1"
Diesel engine	"16 S.V.T."
Continuous rating	1600 b.h.p.
One-hour rating	1750 b.h.p.
Cylinders (sixteen)	10in bore × 12in stroke
Maximum revolutions of engine	750 r.p.m.
Maximum voltage of generator	900 volts
Maximum current of generator	3,000 amperes
Tractive effort:	
Maximum	31,200 lb
Continuous rating	14,000 lb
Length over buffers	63ft 9in
Weight in working order	135 tons
Fuel oil capacity	1,150 gallons
Water capacity (for train heating)	880 gallons

The design of the mechanical portion of the S.R. locomotives was under the control of the Chief Mechanical Engineer, Mr. O. V. Bulleid, until his retirement in September, 1949. The power equipment was dealt with by the Chief Electrical Engineer, Mr. C. M. Cock, until he took an appointment with the Railway Executive. Subsequently control of the construction of the locomotive came under Mr. S. B. Warder on his appointment as Mechanical and Electrical Engineer, Southern Region, in October, 1949.

After the nationalisation of the railways in 1948, the Railway Executive decided that the third locomotive should be built with a different bogie from that designed by the Southern Railway and used on the first two locomotives. The following description, therefore, applies to the locomotives which are numbered 10,201 and 10,202 respectively.

THE ENGINE

The diesel engine of this locomotive is similar to the units installed in the locomotives No. 10,000 and No. 10,001 of the London Midland Region—an English Electric "16 SVT" pressure-charged, sixteen-cylinder vee, four-stroke unit. This engine is rated at 1600 b.h.p. continuously and 1750 b.h.p. for one hour. It is pressure charged by four Napier exhaust gas turbo-blowers, one at each end of each bank of cylinders. The two blowers on each bank charge a manifold common to the eight cylinders of the bank.

The cast Meehanite bed-plate and crankcase are arranged for the direct attachment of the generator frame and the complete engine-generator set is carried on three support points, two at the generator end and one at the pump end. Two castings joined transversely across the centre of the engine form the crankcase and cylinder block of the engine. The camshafts are contained along the front and back of the block. Each cylinder has its own cast Meehanite head and its combustion chamber roof, valve port walls and fuel injector sleeve are water cooled. A light alloy cylinder head cover encloses the valve gear and fuel-injection equipment on each cylinder.

Trunk pistons of heat-treated aluminium alloy have three gas and one scraper ring above and one scraper ring below the gudgeon pin. Each cylinder head has one exhaust and one inlet valve on either side of the fuel injector, and the C.A.V. fuel-injection equipment is provided with one pump per cylinder. The fuel pumps, which are mounted in line with the cylinders, are driven by roller tappets from the camshafts.

The two camshafts, one for each bank of eight cylinders, are carried in forced-lubricated sleeve bearings and are driven by a triple-roller chain and fine-toothed spur gears from the flywheel end of the camshaft. All of the cams are separately attached to the shafts which are built up in short lengths to enable them to be removed in the restricted space available.

A sensitive mechanical governor with hydraulic servo-gear is built integrally with

the engine for fuel pump control. The servo-system is supplied from the engine lubricating system and is so arranged that failure of lubricating oil pressure causes the governor to shut off the fuel supply to the engine. The engine speed is varied from the idling speed of 435 r.p.m. through the intermediate speed of 600 r.p.m. to the maximum speed of 750 r.p.m. by solenoid-operated valves.

Lubricating oil circulating pumps are driven from the free end of the engine through helical gears. Two pumps are provided, suction and pressure. The suction pump draws oil from the sump and delivers it through the radiator to the pressure pump inlet, which delivers it to the engine. Cooling water is circulated through the engine and radiators by two engine-driven centrifugal pumps. The radiator consists of two similar vertical panels of Serck elements, each with oil and water sections. Air is drawn through the elements by a motor-driven fan, and the flow of air can be controlled by shutters operable from the interior of the locomotive.

To ensure an adequate supply of oil when starting the engine there is a motor-driven priming pump which runs until sufficient pressure has built up in the engine lubrication system to operate the governor servo-mechanism, and an automatic pressure switch then sets up the engine starting circuit.

The Main Generator

The main traction generator is a single-bearing machine direct coupled to the engine crankshaft. It is a direct current, self-ventilated, eight-pole machine, and is provided with two separately excited field windings and a series decompounding winding which is also used when the generator is motored from the battery for starting the diesel engine.

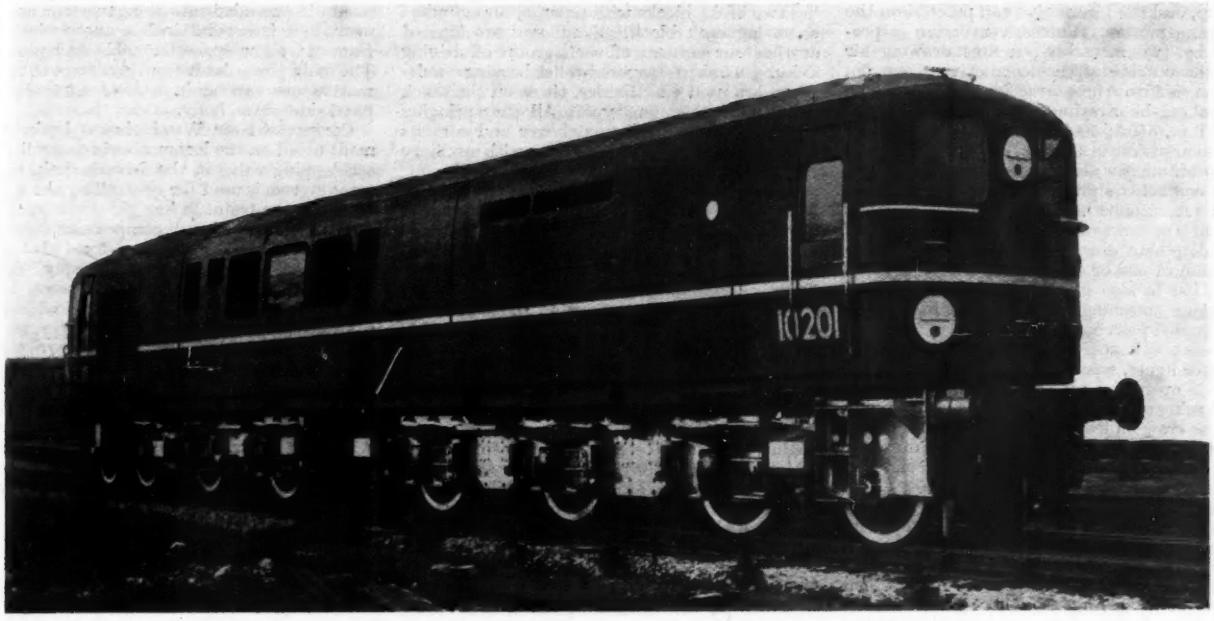
The continuous rating of the main generator is 1155kW, and the current at this rating is 1650A at 700V. The one-hour rating for the machine is also 1155kW with a current of 1750A at 660V.

The single bearing at the outer (commutator) end is a self-aligning roller bearing. An extension of the shaft through the bearing carries the overhung armature of the auxiliary generator, which is a six-pole d.c. shunt-excited machine. There are two ratings, the continuous output being 340A and the one-hour output is 385A, both at 135V. These outputs are available over the whole speed range 430–785 r.p.m. The voltage is maintained constant over all ranges of speed and load by means of a carbon pile shunt field regulator.

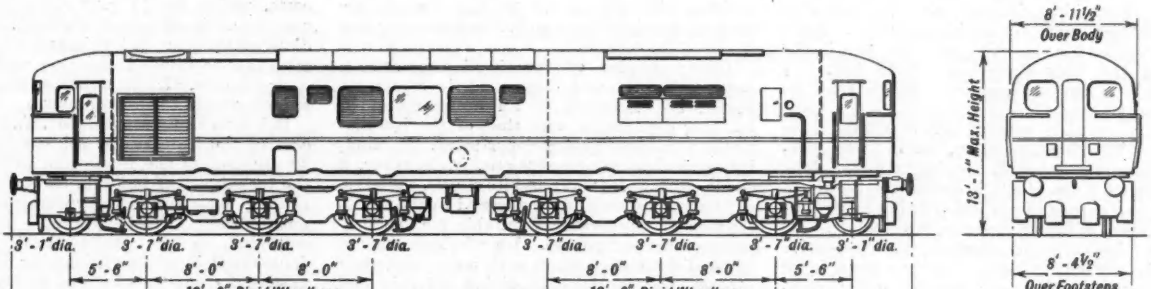
The Control Equipment

The electrical control equipment (including relays, contactors, switches and fuses), which is housed in the compartment between the engine and No. 2 cab, is carried mainly on a centrally placed control frame, fitted with dustproof removable covers for access for maintenance purposes. Separate frames carry the resistances for the generator fields, &c. Air to this compartment is drawn through Vokes filters to ensure a dust-free atmosphere, as the main and auxiliary generators also draw cooling air from this compartment. Apparatus of standard form is used for the electrical equipment. The main traction motor and field weakening contactors are electro-pneumatic, as is also the reverser, while all other contactors are electromagnetic. The control circuits are fed at a constant potential of 135V from the auxiliary generator.

To make full use of the engine horsepower an English Electric load regulator is employed which makes adjustments to the value of one main generator field to suit the load demand. Also at a certain stage the traction motor fields are shunted to give a higher speed/load charac-



SOUTHERN REGION MAIN LINE DIESEL-ELECTRIC LOCOMOTIVE No. 10,201



	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	Total T. C.
Weight in Working Order	12-16	18-8	18-9	17-17	18-10	18-9	18-3	12-8	135-0
Weight Empty	11-4	16-13	16-17	16-7	17-8	17-4	17-3	11-8	124-4

LOCOMOTIVE OUTLINE AND LOADING ARRANGEMENTS

teristic. The full engine horsepower can be used up to 80 m.p.h. by these means.

There are six series-wound, nose-suspended, axle-hung traction motors (type "EE.519/4D") driving three axles on each bogie through single-reduction, straight-spur gearing, with a ratio of 52 : 21. The motors are connected in pairs in series across the main generator and are wound for a nominal 400V. Arrangement is made to cut out a pair of motors should a fault develop, and the locomotive can proceed on the remaining motors. Forced ventilation is provided by two motor-driven fans drawing air from the outside of the locomotive; one fan supplies air to three traction motors. The nominal one-hour rating of each traction motor is 260 h.p., 550A, 400V, and the corresponding continuous rating is 220 h.p., 460A, 400V.

Two automatic alarm systems are embodied in the control equipments, one is for fire detection, as mentioned below, the other is designed to give the crew a preliminary warning of impending shut down of the power unit due to operation of one or other of the safety devices. Indication is also given to the driver of the conditions obtaining on the second locomotive of a coupled pair.

In each cab there is a panel carrying ten indicator lights, one of which indicates that the boiler is operating correctly; it is not part of the warning system. The remaining nine lights give the crew indication of the condition of the power equipment. Normally eight of these lights are alight. If a dangerous condition should arise a buzzer sounds in the cabs and a light appropriate to the faulty circuit is extinguished; at the same time a red light appears and stays alight until the fault is cleared. If two locomotives are running coupled, indication is immediately given to the crew which locomotive is giving trouble. This warning system has been incorporated so that visual indication of an unusual condition affecting the power unit can be detected and remedial action taken to avoid a complete shut down of the power unit in service.

The Locomotive Members

At each end of the locomotive there is a driving compartment which houses the main controller, the driver's brake valve, the control switches which need to be directly accessible to the driver, and the indicator lights and alarms connected to the automatic control system.

A deadman's pedal fitted into the desk opposite the driver's seat has two treads to suit either standing or sitting positions. Seats are provided for the two enginemen and in the end of the body there are double doors for access to a similar locomotive which may be coupled.

For protection against fire two CO_2 foam systems have been installed, one in the engine-room and the other in the boiler-room. The warning is given through detectors and alarm bells, the release of the foam being controlled from either of the driving compartments.

The fabricated underframe of the locomotive is 60ft long and is built from two main inner members of I-section and two light-outer members of channel section. The middle portion of the main members is strengthened by top and bottom plates. Cross members of plate and rolled sections are fitted for carrying the principal loads such as the engine, generator, bogie centres, fuel tanks, water tanks, battery and boiler.

The load from the underframe is transmitted to the bogies through four large segmental bearings, two at each bogie centre, and by four spring-loaded bearers near the outer axles. The top of the underframe is flat and is covered by light steel plate which, in part, forms the gangway floor through the locomotive and is continuously welded to prevent oil seeping through and falling on to the bogies. At the end of the frame there is a retractable platform which can be projected beyond the frame to meet a similar unit on the sister locomotive when two units are coupled together.

The design of the bogie follows closely that used on the three electric locomotives on the Southern Region, described in our issue of March 11, 1949, and has an additional axle for weight-carrying purposes. Its main components are the side frame plates between which are riveted rigid cross stretchers, the middle two carrying the segmental bearings. At the outer end a dragbox is built into the frame and the two spring-loaded side bearers rest on it. The dragbox carries the standard buffers and drawbar.

Side play is given to the middle of the three driving axles, but the other two have only nominal side play. Each of the driving wheels has two brake blocks with separate air cylinders operating each block. Sandboxes are located at the four corners of each group of driving axles. Timken tapered-roller-bearing axleboxes are used on all axles, those on the truck being of the cannon type. All the springing is applied direct to the axleboxes and consists of a laminated spring on each box with auxiliary coil and rubber springs on the links.

The end axle is in the form of a pony truck, but instead of the usual pair of reins centred at a point behind the axle, there are two pairs of short links which are ahead of the axle and are anchored on the buffer beam. These links have spherical bearings which are force lubricated by a multi-feed pump on the side of the bogie and driven from the end of an axle. Side play of the axle is controlled by springs at its rear.

In the construction of the body sheet steel riveted to rolled section framing is used throughout, except for the six hinged covers above the engine, which are of aluminium alloy to facilitate lifting. The middle portion of the sides for a length of 23ft is carried on "Silentbloc" bearings, so that the flexing of the underframe will not strain the body sheeting when the engine generator set is removed. One of these middle portions can be removed if there is insufficient head room to lift the engine generator set through the roof. In addition to the hinged covers over the engine, there are detachable portions in the roof over those items of equipment which may have to be taken out for overhaul.

The wooden floor of the driving compartments is extended into the generator compartment and is several inches above the underframe to allow space for cable and pipe runs. The main power leads from generator to traction motors are carried in a steel duct along the fixed side of the body.

Compressed air Westinghouse brake equipment fitted on the locomotive is controlled by a self-lapping valve in the driver's desk, and the same system is used for controlling the vacuum brake on the train.

Two motor-driven compressors, each of 25 cubic feet per minute, fixed below the middle of the underframe, supply the air required for the pneumatically operated electrical control gear and for brakes, whistle and sand ejectors.

Steam required for heating the carriages of a train is produced in a Spanner "Spiralflo" boiler fitted with Laidlaw Drew automatic oil burner. A continuously running rotary pump feeds water to the boiler through a "Mobrey" control regulator. After the boiler equipment has been started, its subsequent operation is controlled automatically by the steam demand.

Organisation for the Maintenance of Buildings and Installations

By ROBERT CHALMERS, O.B.E., M.I.C.E., M.I.Mech.E.

FOR any company, corporation or authority in possession of a large number of buildings, the question of the best organisation for their maintenance is one of importance and some difficulty, because of the large and increasing extent of the mechanical and electrical installations in modern buildings and the introduction of such installations in older buildings brought about by the demand for modern standards of comfort and amenity and the need for economy.

The principles of functional organisation suggest that the maintenance of the structures should be entrusted to an architectural or building department and that of the installations to the engineering department. A building, including its installations, is, however, a single entity. Its walls and its stoves, radiators or convectors are alike concerned in the maintenance of temperatures suitable for the purposes of its occupation. Its windows and its internal decoration share with lamps and their fittings the function of giving suitable and adequate lighting. Its stairs are often less used than its lifts, but are still indispensable to the same function of access and means of escape in case of fire. Its whole structure shares with appliances the function of precaution against the incidence and spread of fire. These are only a few examples of a unity of purpose in maintenance that is not well served by a division of control which may often lead to such untoward incidents as, for example, the disturbance for rewiring purposes of recently executed redecoration work. There is, therefore, a need for co-ordination of the two aspects of maintenance which is unlikely to be satisfied by two separate forces with no common direction short of a governing body which, in a large organisation, is apt to be remote.

This need for co-ordination of the two aspects of maintenance requires that they be both in the same department of the organisation, and the question then arises whether this body should be the architectural department, the engineering department, or a separate maintenance department. Some disadvantage, of course, attaches to any such allocation which deprives maintenance of the full benefit of the highest and most accomplished technical direction from the architectural or from the engineering side or both, and deprives the architectural or the engineering department, or both, of that close experience of the development of defects, their causes, relative importance and costs, which should play the fullest possible part in the development of design. While these disadvantages are of less importance than those attaching to divided direction with its loss of co-ordination, the organisation should aim at reducing them to the minimum.

It is sometimes argued that, since the capital cost of the installations seldom exceeds 20 to 30 per cent of the whole cost of the building, the techniques of building rather than of engineering constitute the predominant factor in maintenance which should therefore be entrusted to the architectural or building department in which engineering assistants can supposedly supply the engineering technique. This argument is completely fallacious. Economy demands that good practice in both design and maintenance shall be directed to the production of the desired results for the least annual cost of capital charges, operation, supplies and maintenance. When it is remembered that economy in the consumption of fuel, gas, electricity and water is dependent on first-class engineering design and operation, and that the cost of plant maintenance is necessarily much higher in relation to capital costs than is that of structural maintenance, it will be obvious that engineering must play a much more important part in maintenance than is suggested by the first cost of the installations, and in modern buildings the maintenance of the structures themselves is becoming more and more an engineering rather than an architectural function.

Further, the highest engineering science and technology is necessary to economical plant operation and maintenance in a way in which the higher architectural skill is not required in building maintenance. The architect's distinctive functions concerned with planning and

aesthetics have practically no part in building maintenance. And, so far as science enters into building maintenance, it is almost exclusively the science of statics. The engineering work, however, depends on the sciences not only of statics, but also of dynamics, sound, light, heat, electricity and magnetism. There is a very large range of different technologies concerned in the application of these sciences to such various installations as are concerned in steam generation, heating, hot water supply, ventilation, gas services, electrical distribution, lighting and power, lifts, telephones, fire-fighting equipment, fire alarms, wireless and television. In some cases, there may be electrical generating plant, internal combustion engines, private water supply from wells or bore-holes, refrigerating plant, pumping equipment for various purposes, laundries, and large kitchens using steam, gas, electricity and solid fuel, and, in hospitals, sterilising and disinfecting apparatus. The maintenance engineer who could claim mastery of all the science and technology that may be called for in the economical operation and maintenance of all this equipment would be fit for much higher functions. The proper conduct of the operation and maintenance of installations requires the availability of the services of the various experts whose principal function is the design of new installations. The work will be much better and more economically done if the maintenance work, carried on from day to day by the forces under the immediate charge of the maintenance engineer or engineer-in-charge, is subject to supervision, inspection and direction from the chief engineer's department.

Again, a building of quite moderate extent may require the whole-time services of an engineering mechanic and a few stokers, and for economical working stokers should, wherever practicable, be under engineering direction and supervision. Large premises may very well require steam boiler stokers, millwrights or fitters, electricians and labourers under an engineer-in-charge. But the premises that require the full-time services of a foreman of the building trades are very exceptional. The occupants of the premises will want to direct day-to-day reports of defects needing attention to one quarter. They will not wish, and should not be required to consider, whether defects of sash-cords, door furniture, taps, lights, lantern-light ventilation control mechanism, or radiators should respectively be reported to the engineering or the building maintenance forces. Dissatisfaction will arise from failure of promptitude in maintenance attention even if the cause be wrong direction of the requisition. All the whole-time maintenance forces in the premises should therefore be under the single executive control of the engineer-in-charge who normally is always on the premises and constantly available. The engineer-in-charge is, or should be, a skilled engineering mechanic who has acquired some scientific and technical knowledge of a standard not approaching that of the qualified professional engineer, but sufficient to enable him to co-operate intelligently with the latter. He and the forces under him must be in the chief engineer's department.

The services of the experienced building trades foreman are also required. He, however, can cover several premises as visiting inspector. Good organisation requires a clear definite line of authority from headquarters down to the labourer, and each man must know who is his "boss." The building trades foreman or inspector must therefore understand that his functions are advisory and not executive, and the engineer-in-charge that he must accept the guidance of that foreman on all matters of building trades technique and must facilitate his direct guidance to the building trades workman in respect of methods and workmanship. While there may initially be some natural resistance to this delimitation of functions, experience has shown that, if the scheme is clearly defined to all concerned, and firmly insisted upon by the higher direction, these resistances are soon overcome and smoothly co-ordinated work results.

Several engineers-in-charge will be under the direction of a senior maintenance engineer chosen for managerial ability and the superior technical knowledge that enables him to appreciate the need to call in from time to time the appropriate expert advice from the new works staff. Several building trades foremen will be under the direction of a building surveyor who will inspect the various premises from time to time and will prepare the specifications for the larger building maintenance works—for example, the annual cleaning and painting, and will direct the conduct of the contract works on which the building trades foreman will act as clerk of the works, with assistance from the engineer-in-charge, who will keep those works under observation between the visits of the building trades foreman. Headquarters of the senior maintenance engineers and building surveyors may be at the head office of the building owners, or at district offices, according to the geographical distribution of the premises. The head of the whole maintenance organisation will be an assistant to the chief engineer and will have a senior building surveyor as one of his principal immediate subordinates. There will, of course, be co-ordinative consultation at all levels and reference to higher levels in any case of difficulty.

There are disadvantages in any scheme, but the only one in the above is the separation of the architectural new works department from direct maintenance experience. This can be largely overcome if some of the building surveyors—so designated to indicate their maintenance function, although they may in fact be professional architects—are seconded from the architect's department and subject to exchange between departments from time to time.

It is impossible to separate completely maintenance in the strict sense from the execution by the maintenance forces of minor works of alteration and improvement. So far as they involve the building trades, it is a matter for arrangement whether such works, within defined limits, are planned by the maintenance forces, or whether they are planned and specified in the architect's department, the engineer collaborating in respect of installations.

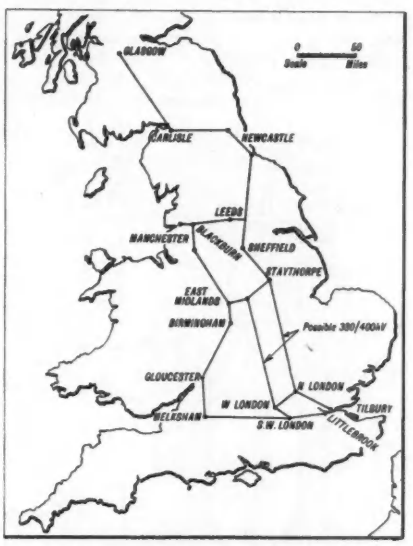
The system above outlined has for its basis the need for engineering direction from the highest levels of engineering operation and maintenance in any premises in which the installations are sufficiently extensive to require whole-time staff of an engineering character. There may, however, be many smaller buildings to which this consideration does not apply, and the arrangements for maintenance of them must depend upon circumstances. Some of them may be situated so near to one of the larger buildings that, for maintenance purposes, they can be treated as annexes. If, however, they are more isolated and scattered it is a matter for arrangement whether they are brought within the same system with the necessary modifications, or whether their maintenance is entrusted to the architect's department, which will call in the engineer when attention to the installations is required, the engineer, in any event, making periodical inspections.

The 275kV Grid Programme

THE British Electricity Authority has now adopted a provisional programme to be undertaken during the next ten years for the development of the 275/300kV reinforcement of the National Grid.

As was announced last year (THE ENGINEER, March 3rd, 1950, page 266), after the preliminary consideration which had been given by the Central Electricity Board to the question of Grid reinforcement, the Authority undertook a comprehensive review of possible future requirements. They reached the conclusion that a substantial increase was necessary in the capacity of lines interconnecting the different parts of the country. Such provision was needed not only to ensure that the most economic and effective use would be made of the generating plant, at a minimum overall capital cost in generation and main transmission but also to enhance the reliability of the supply and make possible the siting of new generating plant at the most suitable sites.

The scheme, which has now been broadly approved by the Authority, is shown diagrammatically on the attached plan and is expected to meet the requirements up to 1960. It provides for lines running from Glasgow in the north via Carlisle, Newcastle and Sheffield to Staythorpe, near Newark on Trent and thence to the London area. From Staythorpe a line will run westwards through the East Midlands and extend northwards to form a ring via Manchester, Blackburn and Leeds. From the East Midlands there will be a second main trunk line direct to the London area and a further connection southwards via Birmingham will also link up with London via Gloucester and Melksham. There will be three main receiving centres on the north, west and south-west outskirts of London, which will be interconnected and extended to form a loop round



PROPOSED TEN YEAR DEVELOPMENT OF 275/300kV GRID

London from Tilbury, on the north bank of the Thames, to Littlebrook, on the south bank. As foreshadowed in the Authority's previous announcement, the voltage of the new system will be 275/300kV but consideration is being given to designing certain sections, notably those connecting the Midlands to the London Area, to be suitable for ultimate operation, if required, at 380/400kV.

For constructional purposes the work will be carried out in stages and the Authority will shortly place contracts covering those portions of the scheme required to be in commission by 1955. The detailed arrangements for interconnecting the new system with the existing 132kV Grid and of coupling in a number of projected new generating stations are still being worked out but it is intended that the greater part of the new lines will have been constructed by 1955, with some sections operating at 275/300kV. In anticipation of the new scheme, one section of line between Staythorpe and West Melton, near Sheffield, was put in hand some time ago and the constructional work is now in an advanced state. The first major extension to be undertaken will probably be the continuation of this circuit from Sheffield via Newcastle and Carlisle to Glasgow, to provide reinforcements urgently required to the North-East Coast.

SCHOLARSHIP IN MARINE ENGINEERING.—The general committee of Lloyd's Register of Shipping has decided to offer a scholarship in marine engineering, valued at £175 per year, and tenable for three years at a British university, to be awarded in 1951 under the auspices of the Institute of Marine Engineers. Full particulars and entrance forms may be obtained on application to the Secretary of the Institute, 85, Minories, London, E.C.3.

A Cold Starting Aid for Diesel Engines

A SIMPLE and effective aid for the cold starting of diesel engines at low ambient temperatures was demonstrated last week at the works of C.A.V., Ltd., Acton, London, W.3.

The problems of cold starting have long been familiar to users and manufacturers of diesel engines, but it is only in more recent years that the need for operating in extremely cold conditions has become anything more than a rather special requirement. For example, before 1938 it was generally accepted, with a view to the needs of the home market, that an engine which started readily at 32 deg. Fah. would be adequate for general purposes and would satisfy most Services' requirements. The usual cold room test procedure was to test at 30 deg. Fah., but the cold winters of 1939–41 emphasised the need for Army vehicles and stationary equipment to be capable of operating at temperatures of the order of 0 deg. Fah. Accordingly this figure was adopted generally as the test temperature.

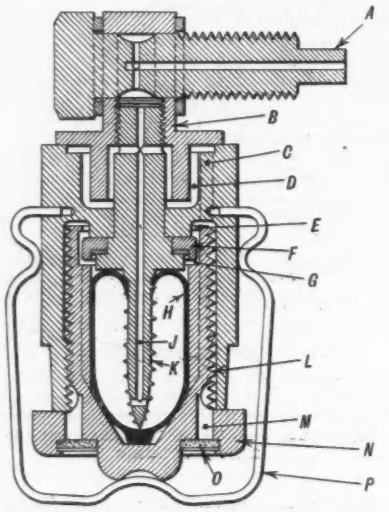


FIG. 1—SECTION THROUGH COLD STARTING DEVICE

For equipment destined for Russia, however, test temperatures down to −40 deg. Fah. were used.

Starting a diesel engine at 0 deg. Fah. without special aid would involve cranking at impracticably high speeds. As alternatives various other aids, such as heating and the use of ignition promoting agents, have been considered. Heating methods include warming of the inlet air, a process which makes too heavy demands on the battery, and the use of a heater plus fuel spray, which requires careful manipulation. Ignition-promoting agents, however, show far greater promise as aids to cold starting.

Experimental work has shown that diethyl ether, introduced into the intake air, constitutes a very effective aid to ignition for the cold starting of diesel engines and after being used successfully in the Services during the war, the method has now been adopted for commercial use in the C.A.V. cold starting device. The function of this ignition-promoter is to provide a mixture which will ignite spontaneously at a lower temperature than the normal fuel-air mixture; the heat of reaction then raises the temperature of the fuel-air mixture to such a value that it will burn. As the ignition process is repeated the engine gains heat until, finally, normal firing proceeds without any aid from the promoter.

The C.A.V. cold starting device embodies two fundamental properties, ensuring reliable starts and economy of ether. First, a rich ether-air mixture is provided during the first stage of cranking to obtain initial ignition. Secondly, after ignition has occurred, the rate of supply of ether is controlled to give a weak mixture, allowing the engine to run, to heat the combustion chamber quickly for running on normal fuel oil only.

The starting aid, which is illustrated herewith, consists, essentially, of a simple charger designed to accommodate a capsule containing

FIG. 2—COMPONENTS OF COLD STARTING DEVICE

7 c.c. of starting fluid with a high ether content. As shown in the accompanying diagram, the outlet connection of the device is inserted in the inlet manifold, in way of the pitot passage of the pneumatic governor butterfly; where a mechanical governor is fitted, a butterfly must be fitted for the operation of the device. In either case cranking of the engine causes a rich ether mixture to be drawn into the manifold.

The device is simple in operation. First the bowl *N* (Fig. 1) is unscrewed, and charged with an unused capsule *H*. The bowl is then screwed into position and secured by the spring clip *P*. As the bowl is screwed up the capsule is pierced by the centre prong *K*. When the rim of the bowl *E* reaches the flexible leather washer or collar *F* the bowl is closed, and during the rest of the "stroke" ether is forced up the centre hole *J* into the annular space *D*. When the rim passes the flexible collar, the bowl is again opened to atmospheric pressure and, finally, the lower joint face is sealed.

On the first cranking of the engine a very rich ether mixture is drawn into the manifold from the annular space *D*, enabling the engine to fire immediately. As the engine gathers speed the depression in the manifold increases. The first few strokes exhaust the ether in the annulus, after which the remaining supply is drawn up through passage *J*. This ether mixes with air drawn in through filter *O*, by way of holes *M*, to the space *G* above the capsule, then through a slot in the thread *L* and holes *C* to the space *D*, providing a weaker mixture, which is sufficient to assist ignition until normal, unaided running on fuel oil only is established. It should be noted that the "starting fluid" in the upper passages and annulus requires only a slight depression in the manifold to overcome its small static lift; the "running fluid," however, requires a greater pressure drop to overcome the increased static lift involved in the passage *J*.

The height of the complete charger, including the bowl clip, is 3¼in. It will be seen from the illustrations that the device is inserted and held in the induction manifold by means of the screwed plug *A* (Fig. 1), the inner end of which projects into the manifold. The body *B* is formed at the top as a lug through which the screwed coupling plug passes.

The starting sequence is not under the operator's control in the sense that he can modify it or change the amount of fluid used. Where a pneumatic governor is fitted the engine

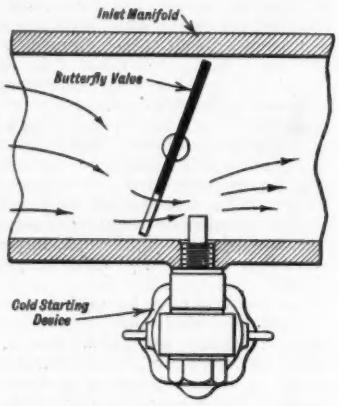


FIG. 3—POSITION OF COLD STARTING DEVICE

is started without depressing the accelerator. As soon as the engine is running, the accelerator may then be operated normally. Where a mechanical governor is used, a butterfly has to be fitted, with separate hand control, and this is "closed" for starting (a suitable hole being provided in it to give the correct depression in the manifold), and opened when firing has commenced.

Typical Test Results

	Engine Number				
	1	2	3	4	5
Unassisted:					
(*a*) Minimum starting temperatures	10 deg. Fah.	20 deg. Fah.	20 deg. Fah.	20 deg. Fah.	20 deg. Fah.
(*b*) Cranking speed	127 r.p.m.	96 r.p.m.	147 r.p.m.	140 r.p.m.	110 r.p.m.
(*c*) Starting time	30 secs.	41 secs.	24 secs.	50 secs.	25 secs.
With cold starting device:					
(*d*) Starting time at above temperature (*a*)	2 secs.	2 secs.	4 secs.	2 secs.	2 secs.
(*e*) Minimum starting temperature	−10 deg. Fah.	−10 deg. Fah.	Not available	0 deg. Fah.	−20 deg. Fah.
(*f*) Cranking speed at temperature (*e*) ...	87 r.p.m.	100 r.p.m.	Not available	108 r.p.m.	80 r.p.m.
(*g*) Starting time at temperature (*e*)	3½ secs.	5 secs.	Not available	2 secs.	6 secs.

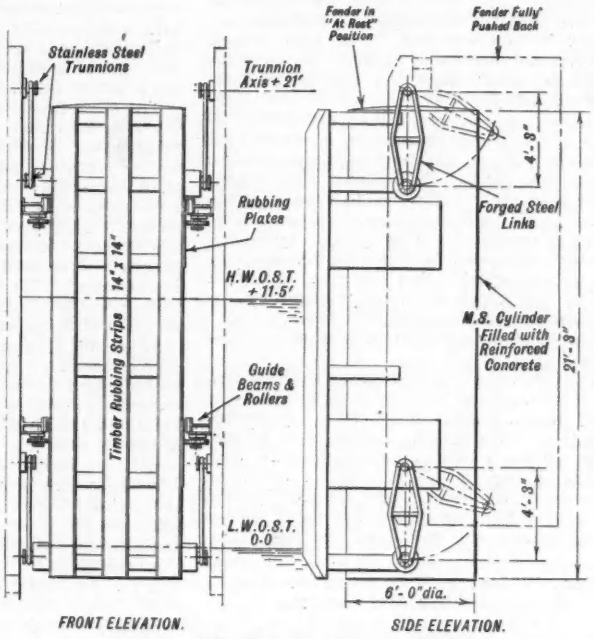
Some indication of the performance of the cold starting device is given in the accompanying table, which relates to tests carried out in a cold chamber on five engines "in the standard condition," after "soaking" to stabilise temperatures at the values stated. It should be noticed that the minimum starting temperature (*e*) is the lowest temperature so far attempted and it is not necessarily the attainable limit. Further, the minimum starting temperatures (*e*) were not necessarily obtained with standard electrical equipment, but the tests were made at the minimum cranking speeds at which starting could be effected. In each test the starting time recorded in the table is the period from pressing the starter switch to the time of switching off the starter.

Commercial production of the cold starting aids to suit engines up to about 6 litres capacity, is envisaged within the next few months, on the completion of exhaustive field trials.

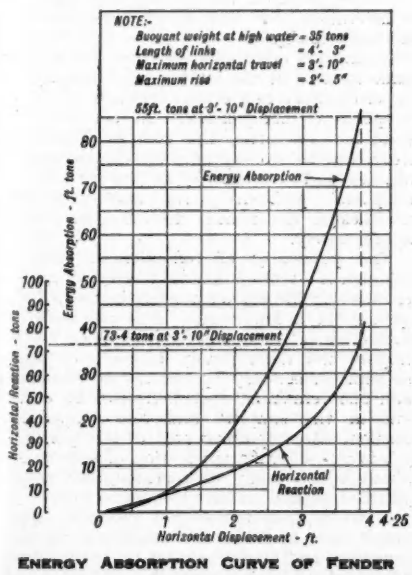
Persian Gulf Port Berthing Arrangements

AN ever-present cause of anxiety to shipowners and harbour authorities is the possibility of damage to ships when being berthed in bad weather. The timber or rope fenders currently in use do not entirely prevent damage even with the addition of devices such as springs and rubber buffers, to give greater resilience. There has always been the risk of a vessel damaging her own hull or the pier by either riding against them or fouling the structure. To overcome the difficulties of mooring ships in heavy weather alongside the quays in the Persian Gulf port of Mena-al-Ahmadi, in Kuwait, the jetty has been equipped with a gravity pattern fender. It is designed to swing both inwards and upwards in response to pressure exerted on it by a ship, thus providing greater shock absorbing capacity, and is shown in the accompanying line drawing. The fender, invented by Professor A. L. L. Baker, was first used in a modified form in a jetty at Heysham in Lancashire and fitted to the "Mulberry" harbours off the Normandy coast.

OIL TANKER "VELUTINA" BERTHED, USING NEW FENDERS



GRAVITY FENDERS AT MENA-AL-AHMADI



ENERGY ABSORPTION CURVE OF FENDER

The "T"-shaped loading jetty at Mena-al-Ahmadi extends 4140ft from the shore and has arms, to north and south, 2805ft and 1076ft in length, respectively. The port is on an exposed coast and subject to high winds and the suspended fender was adopted to give protection to the jetty and to the ships alongside. Our illustration shows the pier and fenders with the oil tanker "Velutina," of 28,000 tons deadweight, moored alongside. Altogether a total of forty-four sets of fenders have been installed and spaced at intervals of from 135ft to 165ft apart. Each set is made up of three fenders, each 6ft in diameter and slightly over 21ft in height and filled with concrete. Each fender weighs about 45 tons, the buoyant weight at high water being about 35 tons, and the maximum reaction of a group of fenders being just over 200 tons. The seaward side of the fender is faced with 14in by 14in timbers and it is suspended by two upper and two lower links, attached to the steelwork of the jetty, which was designed to take the horizontal fender loads. A blow, caused by the inward surge of a vessel, impinging on the face of the fender, forces it to take an upward and inward path, the amplitude of the movement being governed by the magnitude of the blow. The force transmitted to the structure is proportional to the amount of inward movement and to the kinetic energy of the vessel striking the fender, while the amount of energy absorbed by the fender is proportional to its weight and the distance it is raised. The accompanying diagram shows the energy absorption characteristics of a single fender.

Codes of Practice

No. 1, 1950: SITE INVESTIGATIONS

This Code was prepared by a committee convened in 1943 by the Institution of Civil Engineers on behalf of the Codes of Practice Committee for Civil Engineering, Public Works, Building and Constructional Work, under the ægis of the Ministry of Works, for publication in the Civil Engineering and Public Works Series.

In 1949, the responsibility for the preparation and issue of the Codes of Practice in the Civil Engineering and Public Works Series was handed over to the Institution of Civil Engineers, the Institution of Municipal Engineers, the Institution of Water Engineers, and the Institution of Structural Engineers, and arrangements for the preparation and publication of these codes are now made by the Civil Engineering Codes of Practice Joint Committee constituted by those institutions. This code is published by the Institution of Civil Engineers on behalf of the Civil Engineering Codes of Practice Joint Committee.

The code deals mainly with the investigation of the suitability and characteristics of sites as they affect the design and construction of civil engineering works and the security of neighbouring structures. It has been assumed that in selecting the site due regard has been paid to the wider social and economic considerations affecting the community at large. This does not exclude the possibility that two or more alternative sites may require detailed investigation before a final choice can be made.

The code is intended to summarise in a convenient form the information it is desirable to obtain, and has been drawn up in relation to conditions existing in the British Isles. Occasional reference is made to conditions overseas where this has appeared desirable.

Whilst detailed consideration is given to both soil and geological conditions in connection with foundation problems, constructional materials are treated more briefly and, if considered advisable later, will form the subject of a separate Code of Practice. The investigation of the availability of labour, temporary housing, &c., although of considerable importance, is considered to be outside the scope of this code.

Copies of the code can be obtained from the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, price 10s.

A CONTRACTORS' PLANT REGISTER.—A data booklet has been published by Vales Plant Register, Ltd., 14, Lower Grosvenor Place, London, S.W.1, giving full details of the contractors' plant available for hire. This plant includes air compressors and tools of all types and sizes, boilers, concrete mixers, conveyors, cranes, dumpers, excavators, grabs, locomotives, piling plant, pumps, tractors, wagons, &c. The register gives detailed sizes, capacities, &c., of the various machines, and equipment and particulars of the working rules to be observed in its use.

Industrial Design and Its Relation to Machine Design*

By H. G. CONWAY, M.A., M.I.Mech.E.†

It is probably true that, until the introduction of industrial designers some twenty years ago, only occasional efforts had been made deliberately or consciously by mechanical engineers to improve the æsthetic appeal and appearance of their machines. Architectural embellishment was not unknown, particularly in the nineteenth century, when casting design often descended to very low levels of florid ugliness.

Many examples can be found, however, of machines which excite æsthetic appreciation without any deliberate or conscious effort evidently having been put into them to achieve that state. The lessons here are important because many "undesigned" machines are almost beyond criticism. The main reason is that the mechanical designer is to some extent an artist, and often with considerable æsthetic ability.

Although functionalism does not always go hand in hand with appearance, it is true that fitness for purpose does tend to produce designs which look right. The dictum that "what looks right is right" is true to some extent in reverse. The best examples of this are to be found in precision or high-quality equipment, although the appeal here may be influenced by the psychological effect on the engineer's mind; the appreciation of precision by the engineer may not be entirely æsthetic, but may be tinged by an appreciation of what precision means.

Another process, sometimes the most natural, by which machines are improved in appearance (and, indeed, performance) is by the gradual evolution of the design. Design often evolves stage by stage over a period of years, each change giving an opportunity for advances. If, however, the development is forced by sales department requirements, the factor of fashion in appearance will undoubtedly be introduced.

The Introduction of the Specialist Industrial-Designer Consultant

In Britain, industrial designers have hardly graduated beyond the artistic or styling part of the work, although some would include plastic moulding design. In America the better teams devote considerable research into function, utility and market requirements, and a few deal with considerable authority with production cost and the "machine design" proper. The scope in America is obviously much greater than in Britain owing to the vast production demand for almost every type of machine. The need for more careful and balanced judgment in Britain, on the other hand, is evident, owing to the smaller production level.

As in the development of any new movement or method, particularly one which excites popular comment, exaggeration has occurred; many of the products of the American industrial designer exite disgust or horror in the average Anglo-Saxon engineer, but in arriving at a judgment he must remember that, if his products are used in overseas markets, the opinions of his customers may not be the same as his own.

Caution is the only council for the mechanical engineer. The vulgarity and insincerity of the overstyled, chromium-plated and streamlined motor-car of to-day seems incontestable; but in ten years' time it may not appear so bad; the eye may have become accustomed to it. An absolute standard of æsthetic judgment is something an engineer should not attempt to develop. What the industrial designer tells him is the last word in beauty to-day may look very different in ten years' time. Fashion is a powerful factor.

The important point, then, is to avoid non-functional insincerity. An ugly machine covered by a chromium-plated casing can rarely be justified; the streamlining of static objects, or scooters or toys is indefensible.

General Principles of Improved Machine Design

It can be said that machine design may be improved along three lines—those of function, cost and appearance.

Function.—Function relates to what the machine is and what it does, the performance that it gives, and its handling characteristics. From the point of view of selling the machine, it is its specification which is of prime importance. In comparing one machine with another, it is the specification which determines those factors which appeal most to the buyer and will influence his choice. For example, an outboard motor might be improved by replacing the cord which has to be wound round a pulley to start it, by a built-in ratchet-operated knob; a lathe might be redesigned with infinitely variable speed control, or a lift might be fitted with automatically operated doors. Each of these features is an improvement to the specification which would have a notable effect on the ability to sell the machine.

The second, and from some points of view the more important, direction in which machine function can be developed is by improvements to performance, reliability or life, although these factors may sometimes in certain machines be considered as integral features of the specification. In the examples already mentioned, the outboard motor might be made to wear longer, carbon up less quickly, or corrode less in sea-water; the lathe might have hardened slides; the lift might be redesigned to increase its speed of operation. Each of these modifications is an attempt to give the customer a better machine: from the long-term point of view, efforts in this direction are often more valuable to the purchaser than the improvements to the specification already mentioned. However, reliability and durability are factors which can rarely be proved by salesmen and inevitably experience is the only means of determining these aspects of performance. Markets are created by new features in the machine's specification, but lost by failures of performance.

These two improvement factors of specification and performance usually originate, obviously enough, from sales or policy departments and often are more or less dictated to the designer. A very broad field, however, is before the engineer to make improvements based upon the practical performance of the machine in service and from data collected by laboratory research.

By far the most valuable source is field experience. Almost all organisations maintain service departments, field engineers or departments handling customers' complaints. These together provide a continual wealth of constructive criticism and information on performance which is usually substantiated by adequate statistics, particularly when the consumption of spare parts is analysed and taken into account.

Obvious defects in a machine are always reported in such a manner that they cannot be ignored. However, the more subtle defects are either inadequately reported or as often inadequately dealt with when reported. While it is true that no designer could possibly take action on all the defect reports that he received, it is equally true that many do not take sufficient trouble to analyse the reports and take appropriate action, if action is possible. In this connection, a valuable addition to the staff of any chief engineer—if the service department is not responsible to him—is an investigation engineer or engineers capable of going out into the field and digging into performance defects themselves, specifically with a view to improving the product. A balance must be drawn between actual numbers of defects and the percentage of total production at fault, and the decision to introduce an improvement is not one which can be lightly made, particularly when interchangeability is affected.

There is another broad field of work, classifiable under the heading "product research," in endurance or bench testing, laboratory investigation and particularly the make-and-break technique. The general philosophy of this work is deliberately to run the machine to destruction, repair the failure by a suitable redesign and continue the process until further failure occurs. It is generally found that, if this process is carried out for many hours, thousands of cycles, &c., the final result is a product which is rarely more expensive, heavier, or worse looking and has a life of several times the original component. Experience indicates that the final product is, in fact, often appreciably simpler and cheaper. A common example of this technique is in the development of automobile gearboxes. If a box is run to failure on an intermediate gear, minor redesign, elimination of stress concentrations, deflections, &c., will usually enable the same basic gearbox to have a life improvement of 200 to 300 per cent. The durability of almost all comparatively complicated mechanisms can be improved in this way. Interesting examples of the same technique applied to static structures in the aircraft industry has enabled airframe elements to have their effective strength increased, often by as much as 100 per cent, by repeated static testing until failure occurs, with successive redesign of local areas of failure. The net result is a structure which makes full use of local strength form factors and which has the optimum strength-weight ratio.

While this make-and-break technique is to some extent what is almost always carried out during the development of the prototype or experimental component in every firm, it is the deliberate overloading technique which is less usual and which can be so valuable in the subsequent improvement of the machine. If sand causes wear, running with excessive sand is the quickest way to find out how to improve sand resistance. If high speed causes bearing failures, running at high speed will be the quickest way to develop improved bearings.

Manufacturing Cost.—Manufacturing cost is usually studied in relation to the production process and the design, apart, that is, from reductions in cost by overhead economies or by improved business efficiency. The latter are, in themselves, able to effect very appreciable savings, but they are not, at least directly, the province of the mechanical engineer.

The production engineer's job is to reduce cost by reprocessing, by installing new plant and equipment to enable economies to be made, and by introducing quantity production techniques. All these are well known and continually practised.

Perhaps not quite so widely practised is an adequate degree of co-operation with suppliers of material or bought-out parts. Some firms have purchase departments who are either able to contribute to the technique of design or have arranged an appropriate degree of collaboration with the design department to achieve this object.

During his early training, the author spent some months in the buying office helping the buyer discuss a new engine design with outside suppliers of components. In all cases, by suitable discussions, the cost of bought-out items was reduced appreciably (in one case by as much as 75 per cent) by finding out what the suppliers' problems were and persuading the design department to alter the design appropriately.

The possibility of reduction in cost by redesign is a most fascinating aspect of modern engineering and cannot possibly be treated adequately in a few words. The most obvious method is in "designing for production," which implies the detail study of each component so that unnecessary operations are eliminated and the remaining operations can be carried out in the simplest and most expeditious fashion. An important part of this particular job is the scientific application of tolerances—about which many oft-repeated, but usually justified, platitudes have been expressed.

However, possibilities not generally appreciated exist in the concentrated application of ingenuity and inventive steps by special design effort, possibly by specially trained teams. The designer or draughtsman develops a sketch into a design and then, as a result of discussion between a group of engineers over the drawing board, the design, which the draughtsman did

* Institution of Mechanical Engineers. February 2nd. Abstracts.

† Technical director, British Messier, Ltd., Gloucester.

not at the time see how to improve, will be made better, simpler and cheaper.

The development of new materials, particularly synthetic substitutes with attractive properties, enables continual improvements in design to take place. This is usually outside the sphere of the mechanical designer, but it is for him to find means of exploiting them. Similarly, the exploitation of new fabrication and assembly techniques is an essential part of reduction in cost by redesign.

Styling or Industrial Design.—The final direction in which machine design may be improved is in its "styling" or specialised design for appearance. The artist has a job to do after the mechanic has finished, but inevitably in co-operation, whether the artist and mechanic are the same man or whether the artist is an industrial designer. Artistic design in itself is necessary to stimulate sales and, at least from many people's point of view, for basic æsthetic reasons. Whether the engineer agrees that he has this æsthetic responsibility may be a matter of opinion, but few will disagree that the general appearance and "tidiness" of a machine are important factors, particularly where they are manually operated and where the psychological appeal of the machine is important. The colour and finish of the machine are matters of consequence; the decorative relief, however, is a matter which often occupies the attention of the industrial designer, but which the mechanical engineer is likely to regard with suspicion.

Engineering designers are only human and subject to the same likelihood of making mistakes as anyone else. It does seem strange, however, that large organisations with first-class staff and facilities should make such obvious mistakes as they sometimes do. Examples that come to mind are the following:

A new radio set, produced by a firm whose name is a household word, whose wave-change switch is fitted with a knob so small (for appearance's sake ?) that it can hardly be turned; a good-looking machine tool made ugly by fitting an ugly and discordant switch box; a fluorescent lighting unit similarly spoilt by the choke unit; a car without any inside door-pulls on the window moulding so that the window winders are used for this purpose, to their eventual detriment, and the ugly rear window and locker-hinge treatment on another 1950 car.

Fine appearance involves two important factors: the training of designers (or engineers) to achieve an adequate level of æsthetic ability, and the taste or critical ability of the purchaser or user of the machine.

The problem of teaching an engineer to produce designs of fine appearance is as complicated as teaching art students how to paint fine pictures. From a batch of 100 art students, work of a high artistic standard may be expected from, say, fifteen, but a minor masterpiece in oils from not more than one. On the other hand, after a few years' training at least fifty to sixty of the pupils could be expected to produce a reasonably pleasing poster or advertising lay-out.

To expect the engineer to do any better in his own field is unreasonable; but he can be expected, after suitable training, to produce "reasonably pleasing" machine designs or at least to avoid particular ugliness.

Better Product Design

By the Use of Industrial Consultant Designers.—The great virtue of using a specialist consultant to improve product design is that he is much more likely to be kept fresh by continual contact with new material and ideas. The ordinary mechanical designer does inevitably tend to become myopic. No industrial designer could remain in this condition and in business for long. Furthermore, no organisation of normal size could retain a whole-time industrial designer of adequate ability although this does happen in some of the largest American corporations, and in the guise of a "styling department" is not unknown in Britain. If the organisation is large enough, there may still be an adequate possibility for the designer to remain fresh and up to date. Almost every organisation, however small, would benefit from some contact, even isolated, with specialists—even if this only had the effect of making the firm in question design conscious. The results of the stimulus to industrial design which has occurred in Britain since the work of the Council of Industrial Design began to be known can be seen in many of the products of British industry. While the work of British industrial designers themselves is first-class, the effect of the movement on the products of other firms who have not employed specialists can also be noticed. It is quite certain that there is a permanent place for the industrial designer alongside the engineer.

By Management's "Wanting" to Improve Design.—Designers and engineers who, being creative, are continually wanting to improve design, are often prevented from doing so by a short-sighted management or sales organisation. The cost of introducing changes and improvements is invariably offset by the increased sales, or by the retardation of the rate of loss of sales which would occur if the product were not changed.

By the Concentration of Effort and Activity.—Mention has already been made of what can be done to improve design by encouraging the engineers concerned. A good method of achieving this object is to form a group or team of men to tackle the redesign of a particular machine; not only does this allow the maximum concentration of specialised skill which is necessary to achieve the object, but it introduces a degree of interest and enthusiasm for the final result without which any ordinary engineer can scarcely give of his best. Britain has suffered in the past from a notable lack of trained production engineers of the type who could contribute to the success of such a group. Most production engineers have been drawn from the shop floor and the fully qualified and technically trained production engineer is a comparative rarity. What is needed is a type of production engineer competent to study processing problems and at the same time the basic design of the machine itself.

By Training Young Engineers to be Conscious of Product Design.—The instruction in production engineering which the young engineer receives at present in technical colleges and universities is limited to the exposition of common manufacturing processes. If the full advantage is to be gained in product design, much wider and earlier knowledge of new processes must be obtained. The training which the average British engineer receives in kinematics and the study of mechanisms is certainly inadequate. He must be taught to appreciate, classify, categorise and synthesize mechanisms. He must be trained to evolve standard solutions to many day-to-day design problems. The author has had some years' experience with a large number of draughtsmen and designers, often of more than average ability, and he has been surprised how many of them do not know some of the simple solutions to as elementary a problem as the locking of a nut, or the proper design of bushes.

Moreover, the average young engineer receives little or no artistic training. With the accent of modern training on technology rather than liberal education, the prospects for the next generation are no better. The introduction of at least rudimentary treatment on æsthetic design problems would be of considerable value.

Technical Literature.—It happens that British technical journalism, fine as it is, has evolved a series of specialised journals dealing with particular branches of engineering design, but virtually none dealing with machine design in its broadest sense. Whether the existence of two excellent American journals in this field is the result of a greater demand for them in that country, or merely a coincidence, is not known, but it is true that in that country the average mechanical designer is in a better position to keep up to date with activities in fields other than his own and with the development of new processes.

There is a lack in Britain of brochures and booklets dealing with the proper use and exploitation of new materials and processes. Very few industries (with the notable exception of the Copper Development Association) have published information on the design and manufacture of their products to tell the designer how to exploit and make use of such things as plastics or die castings. This criticism is a serious one, because it is not right to expect the engineer to go looking for new techniques; they should be brought to him.

New Manufacturing Techniques

To focus attention on the importance in product design of exploiting new manufacturing processes expeditiously, the progress made in this field in the last twenty or thirty years may well be considered. Many of these processes have had a great effect on appearance, and there is every reason to believe that progress in the next twenty years will be as great. Light alloys, plastics, die castings, welding fabrication, pressings, impact extrusion, upsetting and cold heading, the investment (lost wax) casting process, furnace brazing or soldering, electroforming and powder metallurgy or the sintering process are all materials or processes developed in recent years.

The process of development here is continuous and every year new processes and materials are invented which may eventually be applied to product design, and which will react on the ability to produce the desired effects in appearance.

Conclusions

An attempt has been made in this paper to present the improvement of appearance as a legitimate activity of the normal engineer and to point to the advantages which may arise in many cases from co-operation with the specialist.

It has been realised that appearance should be considered only after the machine design itself has been investigated and every effort made to improve it. The process of improvement, first, should be deliberate, and specialised, but not of necessity by a specialist; secondly, it should relate to performance and function, and thirdly, it should deal with appearance.

It has been pointed out that appearance involves undefinable factors, and if beauty cannot be created synthetically, at least ugliness can be avoided by training.

The point has been made that, however ingenious and industrious is the production engineer, the design engineer himself can often in the end contribute much more towards a cheap, saleable, and successful product by clever and inventive design. The dangers of stifling the designer have been hinted at.

Whether the machine designer of the future will have contact with the specialist industrial designer or not, it is certain that he must understand the parallel importance of appearance and what has for convenience been called "machine design." Since the machine designer is himself a creative artist, he will not find it unduly difficult, with a little help, to add this new responsibility to those he already has.

Canadian Engineers

In the event of war, Canada would experience a serious shortage of engineers, according to a report by the Technical Service Council on the present employment outlook. The report said that during the twenty-two years that the Council had been encouraging Canadian engineers to remain in Canada, the number of engineers *per capita* had increased greatly. Nevertheless, industry had expanded so greatly and civilisation had become so dependent on technology that the large graduating classes had been absorbed; even the record-sized classes of 1949 and 1950 were well received, although opportunities in some fields were restricted. There was a sustained demand for experienced men in many branches of the engineering profession; in August, for example, the number of requests for engineers showed a 58 per cent increase over the same month in 1949. Although these figures were inflated by defence projects arising from the Korean situation, the increasing demand also reflected the industrial growth of the country, and, the report continued, a war would merely aggravate the present trend. The demands of defence industries might be so great that engineers in the less active fields might be required for war plants.

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SUPPLEMENT—Standard 4-6-2 Mixed Traffic Locomotive No. 70,000

THE COAL CRISIS

THE debate on the coal shortage, which took place in the House of Commons on Thursday of last week, revealed little that was not already known about the matter. The Opposition took the opportunity to remind the Government of its promises and prophecies about coal stocks, which, unhappily, have not been more than partially fulfilled, and in the course of the debate the organisation of the National Coal Board was once again criticised. The Minister of Fuel and Power and his Parliamentary Secretary did their best to sound convincing about the brighter side of the coal production picture by emphasising the increase which is now appearing in the mining manpower statistics, by giving some information about the amounts of coal being brought to this country from overseas, and by expressing their belief that "the men who are winning the coal at the face . . . understand the true importance to the nation of the work they do." They then proceeded to the announcement that, in order to maintain the coal requirements of the electricity generating stations and gasworks, it was essential to make an overall reduction of about 15 per cent in deliveries to industry. To that announcement was added the news that the price of coal would be increased by 4s. 2d. a ton as from Monday last.

So long ago as last summer it was realised by the Government, the National Coal Board, and, more particularly, by industry itself, that coal stocks were not being built up rapidly enough to the level required for winter security. It had been hoped that by the end of October there would be a stock of at least 16,500,000 tons with which to begin the winter, but that was a hope which turned out to be 700,000 tons short of fulfilment. In the later months of last year, production of deep-mined coal failed to maintain the improvement that had been noticeable in the earlier months, added to which, mainly on account of a run of bad weather, output from opencast workings was much less than had been anticipated. Thus, by the end of the year, with the worst months of the winter still to come, coal output was declining, consumption was increasing, and distributed stocks had fallen to 12,452,000 tons, a figure 2,300,000 tons less than at the end of 1949. By the middle of January the figure of distributed stocks stood at 10,652,000 tons, and total output was about 4,400,000 tons a week; but total inland consumption was 4,504,000 tons per week, which, with 173,000 tons for exports and bunkers, brought the weekly coal requirements to 4,677,000 tons. The country was thereupon warned by the Ministry of Fuel and Power that it had to face the possibility of a coal shortage within the next couple of months so serious as to throw many people out of work, with resulting serious loss of production, and which might cause much hardship in the home. That statement, made by Mr. Robens, the Parliamentary Secretary to the Ministry, and last week's Parliamentary debate, undoubtedly gave a sharp reminder—if one were necessary—to the public that rigid fuel economy, distasteful as it is in many ways, has become a stark necessity, if worse is not to follow before the warmer weather and longer days of the spring relieve demand. But is it not astonishing that this country should have to face again this winter a situation that threatens consequences as grave as those with which it was afflicted in 1947, and that will unquestionably become just as grave if the weather for the next two months becomes unfavourable? The task of the National Coal Board—a task delegated to it by Act of Parliament—is to get sufficient coal out of the mines to ensure that industry shall not be starved of that essential raw material. Its "Plan," produced a few months ago, will, it is not too sanguine to hope, prove satisfactory as a long-term measure, and progressive mechanisation of the mines should undoubtedly lead to their more efficient operation. But it is not so easy to feel as confident about the success of such short-term measures as the Board and the Government have so far put in hand. The Saturday shift, for instance, about which the Prime Minister made a special appeal at the end of last year, has not yet contributed very much to the extra 3,000,000 tons of coal for which he asked. Nor is the slowly rising trend in the manpower curve—welcome though it is—likely to be reflected in the output statistics for some weeks to come. It is not even certain that the rise will continue. Meanwhile, industry has to face the present parlous situation that should never have been allowed to come about.

In coming to a decision about the cut in coal supplies which has now been inflicted upon industry, the Government, acting wisely, has followed recommendations made by the Fuel Emergency Committee of the National Production Advisory Council for Industry. Those recommendations were explained in some detail in a statement issued at the end of last week by the Federation of British Industries, which is represented on the Council. The statement showed that as electricity and gas consumption had greatly exceeded estimates, coal stocks at power stations and gasworks had been used up at a high rate and, by the beginning of this year, had fallen to a dangerously low level. The Government had then ordered that priority must be given to the replenishment of those stocks, mainly at the cost of coal deliveries to industrial consumers. Much of the benefit of having built industrial coal stocks to a reasonably safe level by mid-December was therefore lost. After examining the possibilities of a system of priorities, the Emergency Committee came to the conclusion that the best course would be to make a level cut in coal deliveries throughout industry, as each firm would then, at least, know where it stood. The F.B.I. takes the view that the reduced deliveries will have to continue at least until Easter. Industry is bound to be sorely tried in these coming weeks by this cut in its coal ration—a cut which might never have been needed if more foresight had been shown by the Government and the Coal Board. But, fortunately, there are certain ways of saving fuel, as, for instance, by reducing space heating, which, though undesirable under more favourable conditions, unpopular, inconvenient or troublesome, can still be effectively adopted in emergency. There is room, too, for some immediate substitution of oil for coal. It is therefore possible to hope that a reduction of coal deliveries to industry limited to 15 per cent will not very seriously affect industrial output, that, in fact, it will bring few, if any, factories to a standstill. Any greater cut, however, must do so, and, unfortunately, it cannot be guaranteed that 15 per cent will prove enough. How much, then, depends upon what the weather does! It is even a significant factor that Easter, since it falls early this year, may close works during colder weather and thereby bring some economy in coal usage! But industry should never have to be asked to take such chances.

Industry will welcome the news that the Federation of British Industries proposes to renew its efforts, as soon as the present critical situation ends, to secure firm action towards the building up of coal stocks to a level at which coming winters can be faced without fear of a renewed calamity. The Federation, like the industries it represents, appreciates very fully that coal stocks cannot be compared with the widow's cruse, and that they do require adequate replenishment each summer if industrial efficiency is to be maintained.

NEW WINGS FOR OLD

EXPERIENCE has shown how hard it is to forecast developments that lie ahead in aviation; some which to-day appear near achievement may in the event not conform to expectation. General trends can, however, usually be discerned, though with an allowance for the operation of such factors as the sudden adventures of designers, and the swift preferences and foibles of the air-travelling public. An illustration is seen in the striking rise in performance of which new civil aircraft are shown to be capable, and the reported queueing-up by the public for early bookings on the new fast "Comet" services. The public taste for high-speed travel seems almost insatiable, despite the advantage of lower speeds as leading to greater safety and to lesser operational costs—especially if those costs take into account, as properly they should, the interest charges and maintenance costs of to-day's great airports. From the complete returns now available for the year 1949 one finds that of the ten leading air-lines (outside the "iron curtain," of course), the largest five, all American, each with a ton-mileage of 100 millions or more, showed a total profit of some £11 million, whereas the other five each with a ton-mileage below that level, made a loss of about £13 million—in each case omitting interest and taxation costs. Conditions in America are so much more favourable than elsewhere that it is not surprising that their financial returns should be better, but all alike, solvent or not, have to face the demand for still higher speeds and, in consequence, for better airport facilities, meteorological services, and navigational aids.

The prospect of combining safer flying with cheaper airports, even under present conditions, was the brave theme chosen by Sir Frederick Handley Page for his 1950 Blériot Lecture before the French Association of Aeronautical Engineers and Technicians. He pointed out that before World War II we were content with runways, even grass-surfaced ones, no longer than 3000ft, whereas the new ones, such as those at London Airport, have to be three times as long and have to be built of concrete; such airports may cost the Governments providing them anything from £25 million upwards. The contrast in requirements is a subject for anxious consideration by air-line operators, aircraft designers and airport authorities alike; such high capital and upkeep charges must inevitably be reflected in flying costs in one way or another, and so prejudice the future of civil aviation. As the introducer many years ago of the virtues of the slotted wing, it was natural that Sir Frederick should give his opinion as to what might be done by improving wing design, as well as in other ways, to reduce landing speeds and make flying safer. He thought in the first place that aeroplane designers could help greatly by giving more consideration to wing design and particularly to devices for controlling the air boundary layer—he commended the possible use of rocket assistance in this respect—and that greater attention should be paid to the improvement of undercarriages—particularly in the direction of their simplification and lower weight—even perhaps going so far, once landing speeds were reduced, as to adopt skid landing devices, which with their very low weight would give a substantial increase in payload capacity. This prospect of "new wings for old" has obvious attractions, and the next move is with the designer and inventor.

Far removed from the great multi-engined airliner, civil flying has within its range those modest craft which soar and glide without any engine power at all, and, as it happens, recent work in this field is as interesting as that in any other form of flight and may in the end prove to be as important. Mr. Rasket, a research worker at the Mississippi State College, has recently presented an account (published by the Institute of Aeronautical Sciences) of some flying experiments he has made with the friendly co-operation of certain large birds long known to have great capacity for wing control and possessed of exceptional gliding and soaring ability. The observers' early attempts to use engined craft showed that the birds sought ardently to avoid the presence of anything so unpleasantly noisy. But to the proximity of craft as silent as themselves the birds had no objection—unless the observer in the air chanced to address his radio-telephone too loudly when communicating with associates on the ground. The local conditions of the experiment caused the turkey buzzard to be the favoured bird-associate, and it was soon found that it had so high a flying performance as to raise the question long ago mooted by Lord Rayleigh whether dynamic soaring might not be possible—that is, by means of power drawn directly from turbulence in the atmosphere. Mr. Rasket's plan of study originated, it seems, some five years ago with an experiment in which a bird was "trained" to carry a barograph and ammometer! But, unfortunately, it did not live long enough to be able to present any results; so it was decided that it would be better to fly in company with untrammelled birds, watch them closely and record their performance by camera and rangefinder. The investigation is still in its early stages, but it already appears that the black buzzard has a minimum drag coefficient of about one-half of that of the cleanest modern aircraft; indeed, the conclusion reached by the experimenters is that the bird seems able to control the airflow over wing and body so that it is laminar everywhere. Though how this long-sought ideal is achieved (if, indeed, it is) is another question. It might perhaps be an effect of the unsymmetrical porosity of a feather-covered surface, but whether the bird has in some way succeeded in extracting energy from atmospheric turbulence has still to be proved; at present it is but suspected. Much interest attaches to the continuance of this promising investigation, for even if it seems chiefly to concern the very light end of aviation, there may be possibilities of application at present unsuspected.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

AN INTERNATIONAL CARGO HANDLING CO-ORDINATION COMMITTEE

SIR,—Sir Wilfrid Ayre, in an editorial in the latest issue of the *Burntisland Shipyard Journal*, refers to the general increase (in spite of the "it-doesn't-pay" school) in sea speed of ships. Sir William Currie has referred to the fact that for the East African trade five fast cargo passenger ships are needed to do the work of four because of port delays. Mr. MacGillivray recently presented a classic paper to the Institution of Naval Architects dealing with the inter-relationship of sea speed and port speed. In it he detailed some of the amazing devices which have recently been produced for the rapid mechanical handling of cargo. It is, indeed, no exaggeration to state that many ship types can be built to-day which are automatic in the discharge of their loads and sufficiently rapid in doing so to enable them to co-ordinate their sea and port speeds. Equally, shore equipment, and particularly "pallettisation" and the use of forked trucks, is so efficent that much labour can be dispensed with, and a high rate of loading and discharge achieved with certain kinds of cargo.

But most of the developments of this kind are localised. There is neither standardisation of design nor co-ordination of knowledge and experience. Both of these are essential if the naval architect, by what he puts into the design of his ships, is to increase port speed. It is useless to have, for example, in port a device which can remove cargo quickly from certain ships, but which cannot handle others with equal celerity because hatches or side doors are inconveniently placed. Lack of co-ordination of this kind caused some embarrassment in those anxious times before D-Day when exercises were taking place with landing craft and landing ships, tank and armoured fighting vehicles. The Army had designed some of its vehicles without consultation with the Navy, with the result that difficulties were experienced in getting the "aft ends" of the vehicles over the ramp and special ramp additions had to be fitted. True co-ordination would have prevented this. There is no doubt that a situation of a similar nature has developed in the ports of the world and in the ship types which are being evolved to-day.

It has, therefore, been suggested that an international Committee, known possibly as the International Cargo Handling Co-ordination Committee, might be established. This will be purely unofficial, though of prime importance, in the first instance to manufacturers of rapid cargo handling gear. The basic idea has been promulgated in France and there is considerable interest in it in Holland.

I have been asked to initiate steps which might make possible the eventual formation of such an international organisation, which would be truly international and completely non-government. I am informed that certain of the technical institutions would at least like, however, to hold a watching brief. It would be interesting to have the ideas of your readers as to the establishment of such an organisation, which would make possible the free interchange of all information about the newest devices for handling cargo rapidly, both those attached to shipboard and those on shore.

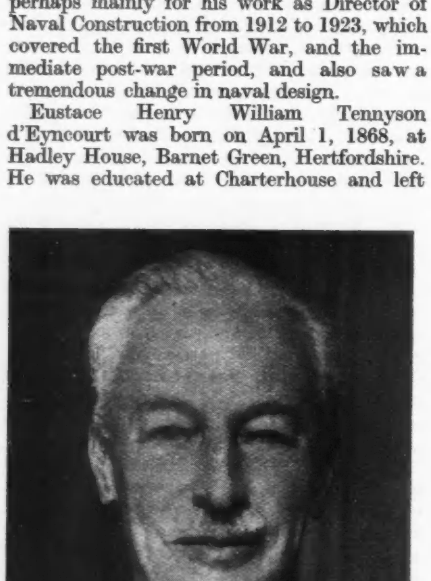
London, February 1st. A. C. HARDY

Obituary

SIR EUSTACE H. W. TENNYSON D'EYNCOURT, Bt.

THE news of the death of Sir Eustace Tennyson d'Eyncourt, at his home, Carter's Corner Farm, Hailsham, Sussex, on February 1st, at the age of eighty-two, has brought a sense of personal loss to many in the shipbuilding industry and particularly those associated with naval construction. Although he had retired from active participation in business, Sir Eustace will be remembered for his distinguished service in many fields, but perhaps mainly for his work as Director of Naval Construction from 1912 to 1923, which covered the first World War, and the immediate post-war period, and also saw a tremendous change in naval design.

Eustace Henry William Tennyson d'Eyncourt was born on April 1, 1868, at Hadley House, Barnet Green, Hertfordshire. He was educated at Charterhouse and left



SIR EUSTACE TENNYSON D'EYNCOURT

there in 1886, but did not proceed to Oxford because his parents had realised that his inclinations were towards engineering, and so he was advised to adopt naval architecture and shipbuilding as a profession. His apprenticeship was served at the Elswick Shipyard of Sir W. G. Armstrong Whitworth and Co., Ltd., and he also studied at the Royal Naval College at Greenwich to complete his technical education. After serving a further seven years as an assistant constructor under Sir Philip Watts, Sir Eustace joined the Fairfield Shipbuilding and Engineering Company, Ltd., as naval architect, under Dr. Francis Elgar, to gain experience in merchant shipbuilding. Four years later, in 1902, he returned to Elswick when Sir Philip Watts left to become the Director of Naval Construction. During the next ten years, Sir Eustace visited many countries, including Argentine, Brazil, Chile, Spain and Turkey, to negotiate naval contracts, and for his services to the Turkish marine he was awarded a Third Class Medjidie.

In 1912, Sir Eustace was appointed to succeed Sir Philip Watts as Director of Naval Construction, and there followed a period of intense activity during which a large number of varied classes of vessels were designed and built to meet the menace of the German navy. Under him, the "Royal Sovereign" class of battleships was built, and also the "Renown," "Repulse" and "Hood," and the famous fast light battle cruisers "Furious," "Glorious" and "Courageous." Many of these vessels served with distinction in both World Wars, the latter vessels as aircraft carriers. Sir Eustace was responsible for the development of many other naval vessels, such as the "C," "D" and "E" class cruisers, the famous "Flower" class sloops, and many submarines ranging from the "E" class onwards, including the revolutionary "L" vessels, with boilers and turbine machinery to give a surface speed of 24 knots, and the large "M" class, which mounted a 12in gun. Another item of interest was the development of the bulge method of underwater protection against torpedo attack.

Apart from his activities connected with the Navy, many demands were made upon his skill and energy, and he was chairman of the committee responsible for the design and construction of the first tanks. Yet another job was the building of the airships "R 33" and "R 34," under Admiralty supervision, the latter making the double crossing of the Atlantic. During the first World War many honours were awarded to Sir Eustace. He was created a C.B. in 1915 and made an F.R.S. in the same year; in 1917 he was given the K.C.B. The United States Government awarded him its Distinguished Service Medal, and the French Government created him a Commander of the Legion of Honour. After the war he served on the War Office Tank Committee and was responsible for the design of the Washington Treaty battleships "Nelson" and "Rodney."

Sir Eustace relinquished the office of Director of Naval Construction in 1923 to take up the position of managing director of Sir W. G. Armstrong Whitworth and Co., Ltd., and again found himself visiting South American countries to discuss orders for naval vessels. His many other activities included acting as consultant naval architect and engineering director of Parsons Marine Steam Turbine Company, Ltd., from 1928 to 1948; director of La Sociedad de Española di Construccion Naval, and membership of the Grand Council of the Federation of British Industries. He was appointed to many committees, including the Engineering Joint Council in 1927, and the Chairmanship of the Advisory Committee of the William Froude National Tank. The years brought further honours, and he was created a Baronet in 1930, elected a Foreign Associate Member of the French Académie de Marine, and, in addition to the D.Sc. already bestowed by Durham University, he was made an LL.D. by Cambridge University.

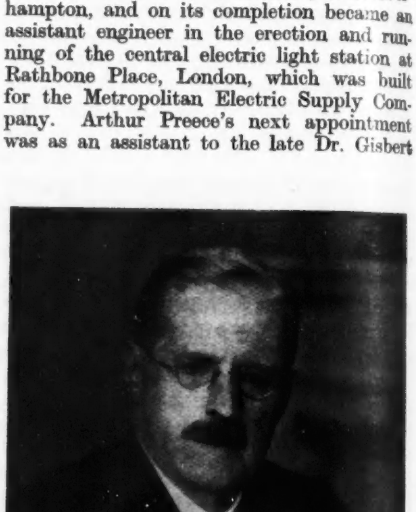
Apart from his many duties, Sir Eustace found time to take an active part in the activities of several professional bodies. He was a member of the Institution of Naval Architects, and of the Institution of Civil Engineers, and served on the Council of the former institution, being elected a Vice-President in 1916. Other offices included President of the Junior Institution of Engineers in 1920, President of the North-East Coast Institution of Engineers and Shipbuilders in 1925, and Master of the Worshipful Company of Shipwrights in 1927. He read many papers before the learned societies, delivered the James Watt Lecture in 1924, and published his book, "A Shipbuilder's Yarn in 1948."

A memorial service has been arranged and will be held at St. Margaret's Church, Westminster, at 12 noon on Wednesday, February 14th.

SIR ARTHUR PREECE

THE death of Sir Arthur Preece, which occurred at Quains, Virginia Water, on January 31st, will be deeply regretted by his many friends in the civil and electrical engineering professions. For fifty-six years he practised as a consultant in Westminster with the firm which he founded in 1893.

Arthur Henry Preece, who was born on August 16, 1867, was the second son of the late Sir William Preece, F.R.S. He was educated at King's College School and in Germany, and also studied at King's College, London. In 1887 he began a pupilage with Elwell Parker, Ltd., contractors, of Wolverhampton, and on its completion became an assistant engineer in the erection and running of the central electric light station at Rathbone Place, London, which was built for the Metropolitan Electric Supply Company. Arthur Preece's next appointment was as an assistant to the late Dr. Gisbert



SIR ARTHUR PREECE

Kapp, in whose office he was engaged for two years on the preparation of plans and specifications for the Bristol electric light station.

In 1893 Sir Arthur started his practice as a consulting electrical engineer and, as the years passed, was responsible for the design and construction of many of the early electric generating stations, including those at Hammersmith, Wimbledon, Llandudno, Kingston-on-Thames, Gibraltar and Malta. The practice increased and when Sir William Preece retired, early in 1899, from the position of Engineer-in-Chief of the General Post Office it was merged in the firm of Preece and Cardew, the partners being Sir William Preece and his two sons, Llewellin and Arthur, together with the late Major Philip Cardew, who had retired from the post of electrical adviser to the Board of Trade. For the rest of his working years Sir Arthur Preece's activities were concerned principally with the demands for electricity supply not only in this country but in many parts of the world. His advice on electrical matters was sought by the Government of India, by the Argentine Republic and several other countries. Sir Arthur was among those who soon became convinced of the benefits to be derived from adequate and efficient electricity supplies

in the Colonies and to the work of their establishment he devoted considerable attention. His services to the Empire were recognised in 1932, when his knighthood was conferred.

Sir Arthur was a member of the Institution of Civil Engineers and in 1898 was awarded a Telford Medal and Premium for his paper on "The Electricity Supply of London." He was also a member of the Institution of Electrical Engineers and an LL.D. of the University of Hong Kong. For some years Sir Arthur had been troubled by failing eyesight, an affliction which compelled him to retire, on medical advice, two years ago.

THOMAS TURNER

A NOTABLE career in metallurgy has come to an end with the death of Professor Thomas Turner, which occurred at his home, Netheridge, Elm Drive, Leatherhead, on January 31st, in his ninetieth year. For twenty-four years he was Professor of Metallurgy in the University of Birmingham, where he was also Dean of the Faculty of Science.

Thomas Turner was born in Ladywood, Birmingham, in 1861, and received the earlier part of his education at a private school in Edgbaston. Subsequently he studied at the Royal School of Mines, London, and in 1883 he was appointed a demonstrator of chemistry at Mason College, London. There he began his studies of the influence of silicon on the properties of iron and steel, and later became lecturer in metallurgy at Mason College. In 1894 Mr. Turner was appointed Director of Technical Instruction to the Staffordshire County Council, a position which he occupied for the next eight years. The next period of his career, which may be said to have established his reputation throughout the country, was from 1902 to 1926, when he was the first holder of the Chair of Metallurgy at Birmingham University. In that appointment, Professor Turner was responsible not only for the design and equipment of the metallurgical department of the University, but also for the technical training of many well-known metallurgists of the present day.

Professor Turner was elected to membership of the Iron and Steel Institute in 1887, was appointed to its council in 1924, and was elected an honorary vice-president in 1931. The Institute's highest honour, the Bessemer Gold Medal, was awarded to him in 1925 for his distinguished services in the advancement of the science of metallurgy of iron and steel. In addition, Professor Turner took a leading part in the formation of the Institute of Metals in 1908 and was its treasurer for the first ten years of its existence. Later, he was elected President and in recognition of his many services was appointed a Fellow of the Institute. There were other honours which were deservedly bestowed upon Professor Turner, among them being the Seaman Gold Medal of the American Foundrymen's Association and the E. J. Fox Gold Medal of the Institute of British Foundrymen. In 1921 a trust was established for the award of the Thomas Turner Gold and Bronze Medals and prizes for metallurgy at Birmingham University.

In addition to his researches on the influence of silicon and other elements on iron and steel, the results of which have been applied in iron foundries throughout the world, Professor Turner was the author of papers on several other subjects, including the puddling of wrought iron, the reheating and rolling of finished iron and various aspects of the study of hardness. His expert knowledge was widely recognised by numerous technical organisations and by the Government, and there are many committees and technical organisations which have benefitted by the advice he was at all times ready to give. Professor Turner was an examiner in metallurgy to the Universities of London, Edinburgh, Glasgow, Manchester, Birmingham and Wales, and to the Civil Service Commission and the City and Guilds Institute.

Upon his retirement from Birmingham University in 1926, Professor Turner was given the title of Professor Emeritus, and for several years afterwards he engaged in consulting work. His old students, and all who came into contact with him during his distinguished career, will keenly regret his death.

F. L. WATSON

WE regret to record the death of Major F. L. Watson, which occurred at Lyndhurst, Hants, on January 26th, in his eightieth year. The greater part of his career as an engineer was spent in Leeds, first with the firm of Joshua Buckton and Co., Ltd., and subsequently as a consultant.

Frank Leslie Watson was born at Shirburn, Oxon, and was educated at Cheltenham Grammar School and in the Engineering Department of Leeds University, or the Yorkshire College, as it was known in his day. He served an apprenticeship with the Hunslet Engine Company, Ltd., Leeds, and then for three years, from 1896 to 1899, he was an engineer and manager in that company's works. In 1899 Watson became general manager of the Horsfall Destructor Company, Ltd., in which appointment he was engaged until 1912 on the design and construction of plants for the disposal of town refuse. Major Watson was then invited to join Joshua Buckton and Co., Ltd., machine tool and testing machine makers, of Leeds, and there he remained as secretary for two years, until he was mobilised for service in the first World War. But he was recalled from the Army in 1917 by the Ministry of Munitions to organise and equip the national gun repair factory at Leeds, and was later transferred to the Admiralty as Deputy-Director of Ammunition Production.

After the war Major Watson returned to Joshua Buckton and Co., Ltd., as managing director, and when the business was taken over in 1928 by Craven Brothers (Manchester), Ltd., he served for a time on the board of the latter company. He then carried on an agency, consulting and valuation business in Leeds for some years, until his retirement to Lyndhurst. Major Watson was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers. He served three terms as chairman of the Yorkshire Branch of the "Mechanicals," in 1922, 1930 and 1931, and was also, for five years, president of the Leeds and District Engineering Employers' Association.

OSWALD WANS

WE have learned with deep regret of the death of Mr. Oswald Wans, formerly chief engineer and director of Ruston and Hornsby, Ltd., which occurred at The Manor House, Wellingore, on February 2nd. We hope to publish an appreciation of Mr. Wans in our next issue.

Industrial Coal Supplies

FOLLOWING the House of Commons debate on Thursday of last week on the coal situation, the Ministry of Fuel and Power made an announcement about arrangements for coal supplies to industry. Those arrangements, it was stated, had been decided upon after consultation with the National Production Advisory Council for Industry.

In view of the prevailing coal shortage, the Ministry said that deliveries to industrial firms would be, on average, about 85 per cent of their allocations, subject to the normal hazards of transport and performances at individual collieries. Unless the situation became worse, no priority would be given to particular industries at the expense of others, as priorities for particular industries would still further reduce supplies to the others and would inevitably cause dislocation. The Ministry's main purpose, the statement continued, was to ensure that industry should know what average rate of supply might be expected. It would then be for each firm to decide how to economise and reduce its coal consumption so that the reduced supplies could be used to the best advantage. Where there were firms with stocks at a low level because of limited stocking space, or because of proximity to collieries, the Ministry's Divisional Coal Supplies Officers would, where possible, continue the assistance now being given to keep in operation the firms with less than one week's coal stock. Where, by reason of fuel economy, a firm had been able to improve its stock position, its foresight would not be penalised by reducing current deliveries, and provided its stocks did not amount to more than six weeks' consumption, no steps would be taken to reduce deliveries because its stocks were higher than the average. The statement indicated that machinery would be set up under the Regional Boards for Industry to deal with arrangements between individual firms which agreed to pool their coal supplies and close certain plant so as to run other plant fully; to reduce coal supplies to firms whose production was being substantially curtailed by raw material shortages, and to determine the coal supplies to be allocated to any new firm or plant due to come into operation in the next three months. The Ministry added that similar arrangements would also be applied to coke, deliveries to industry being at 90 per cent of the programmed requirements, except in the case of blast-furnaces and foundries for which "special action" was necessary.

Information made available by the Federation of British Industries at the end of last week amplified the Ministry's announcement, and gave some details of the action taken by the Fuel Emergency Committee of the National Production Advisory Council for Industry. The F.B.I. said that, after an examination of various economy measures, it informed the Government that the level cut in industrial coal supplies was the course likely to do least damage, so long as the extent of the cut did not exceed 15 per cent or thereabouts. If the situation worsened, however, the whole question would require reconsideration. Industry must proceed on the assumption that the 15 per cent reduction in coal deliveries would last up to Easter, which was the best that could reasonably be hoped. Every saving which could be made in gas and electricity consumption as well as solid fuel would contribute to the avoidance of a still greater crisis. Those firms which could obtain oil and put auxiliary generating sets into regular use would help the general situation by so doing. Finally, the F.B.I. stated, as soon as the present crisis ended it would renew its efforts to secure action which would build coal stocks to a level at which industry could face next winter without another calamity.

TINPLATE EXPORTS.—A written reply by the Parliamentary Secretary to the Board of Trade states that United Kingdom exports of tinplate of all kinds during 1950 amounted to 247,000 tons. It is not possible to say how much tinplate will be exported this year.

Industrial Design and Machine Design

THE INSTITUTION OF MECHANICAL ENGINEERS

No. I

AT a general meeting held at the Institution of Mechanical Engineers, London, on Friday, February 2, 1951, the following paper was presented and discussed :—

"Industrial Design and its Relation to Machine Design," by H. G. Conway, M.A., M.I.Mech.E. An abstract of the paper begins on page 190.

DISCUSSION

Mr. Gordon Russell, who opened the discussion, said that he had been particularly interested in that part of the paper which dealt with education, because the problem seemed to be an educational one. The engineer, in altering the whole face of civilisation, had raised many problems, and it was only right that the engineer should himself consider some of those problems with a view to seeing how they could be solved. The engineer very often underestimated his own capacity to produce a good design and was inclined to think that what he called art had nothing to do with him, and, unfortunately, owing to the peculiar system of education in this country, in which there was a complete break between technical and art education, it was only too easy for the engineer to take that point of view.

The engineer was the guardian of quality, and a good standard of design depended primarily on a thing being reasonably well made. Moreover, in a great many engineering trades, the engineer was dealing directly with the customer, as, for instance, in the building of bridges and the making of machine tools, and not with a retailer. When the man who actually knew how a thing was designed and made was dealing directly with the man using it, he could explain the quality; whereas it was fatally easy for the retailer to sell entirely on price because he did not know enough about it to explain why a thing should be more expensive.

The unfortunate thing in the civilisation that had been built up in England was that there was so much ugliness about that people had forgotten what could be done to make so many things beautiful. A few days ago, in looking at a book on the steam engine, which had been published a hundred years ago, he had been struck by the beauty of the plates and illustrations and by the admirable design of the engines and the good lettering on them. At that time the engineer had been working inside the background of the eighteenth century civilisation, and probably at that time half of all the buildings around him were good. In such surroundings and with such a background, it had never occurred to him to put on his engines the horrid lettering which British Railways nowadays put on their engines and carriages!

Mr. S. W. Lister said that the paper set out to throw light on that difficult problem of why one machine looked right and another looked wrong, even though both might work equally satisfactorily.

It was certainly a fact that the engineer could learn by studying work which artists had done, and especially the applied arts, like architecture. Anyone looking at a famous building, such as the Parthenon at Athens, was struck at once by its simplicity, its good proportions and the restrained use of ornament. Those were also vitally important qualities in any good engineering design. A derivative of the classical style, namely, the English Renaissance, had similar qualities, but in its later baroque period it had begun to get decadent by being too preoccupied with curves and florid decoration. American motor car design had developed the same preoccupation with curved surfaces and decoration. It might also be said that that style was becoming decadent.

Another point to remember was that the architect and the sculptor were always very much aware of the materials they were using. A building or a statue in marble was treated quite differently from one made of granite. The engineer needed to remember that he was working in iron and steel, and his designs should have in their appearance something of the hardness and rigidity of iron or, perhaps, the ductility of steel. Here, again, the American car struck a false note. With its bulbous curves and rounded form it might be made of jelly or indiarubber.

Then there was the question of honesty. It was vitally important that the engineer should be strictly honest in his work. An extra lump of metal added to a design at a point where there was no need to cater for stress or rigidity was what Professor Inglis at Cambridge used to call a structural lie, and in his opinion the worst of all possible sins for an engineer. There was no doubt that a design which did little more than take comfortable care of stresses and rigidity looked right even to a layman, and in its honesty it might have æsthetic appeal also. Good bridge design was an example of this.

The author had mentioned functionalism in design. Sailing ships which had at one time carried the trade of the world were notoriously dangerous things, so much so that no sailor would dream of sailing in a ship that did not have a good reputation for behaving well in high wind or rough sea. Consequently, generations of ship designers had been primarily and almost exclusively concerned with good sea-going qualities, and this purely functional consideration had produced ships which had such distinction and such integrity as to be real works of art. Similarly with aeroplanes, where concentration on the functional quality of being good in flight had produced great beauty of form.

Mr. F. D. Holister said that he must join issue with the author on at least four points. First, the author referred to the industrial designer in such a manner as to suggest that he or she was a single individual. Personally, he (the speaker) felt that this was a somewhat unfortunate reference, since it was his opinion that there was no such thing as an industrial designer in the same sense as one had a Henry Moore or a Barbara Hepworth. Industrial design was, in his experience, the function of a team, although admittedly the team might have at its head a Wells Coates or a Raymond Lowey; but it must be a team of artists with practical experience in product production and of fully qualified engineers "with their feet firmly on the ground." Such a team must be able to conceive, create, engineer and develop a product and, when required, plan its production and not leave it until it was coming off the production line.

Secondly, he disputed the author's statement that in Britain industrial designers had hardly graduated beyond the artistic or styling part of the work. He admitted that industrial design had not yet assumed in Britain the importance that it had attained in America, but there were nevertheless teams in this country such as he had described who successfully operated in spheres in which they were competent.

Thirdly, the author seemed to suggest that industrial design and what he termed machine design were separate functions that were only very remotely related. This was a very unfortunate suggestion, and he hoped that the idea would soon be dispelled that an industrial designer was merely someone to be engaged or called in to "doll-up" a piece of mechanism that had already been mechanically designed. Finally, he stressed that industrial design was not applicable to mass production only. In fact, as the qualified industrial designer ranked functional considerations as one of the pre-eminents, there were quite a number of one-off jobs that could very materially benefit from the attention of the industrial design team—a fact which he had established by actual experience.

Mr. W. Duffy said that he was one of the few full-time industrial artists employed by an electrical and general engineering concern producing consumer, industrial and capital goods, and his services were at the disposal of every department in the organisation. Starting with his firm in 1932 as a so-called "eye value man" (in a part-time job to start with), it had soon become apparent to him that real design was not a question of glamourising the technical design, but must be a joint effort starting from the first rough draftings of the general arrangement. For machine designs the shape grew naturally from its functioning and its use by the operator and any conscious striving for dynamic effect in a preconceived form could lead to dishonesty in design.

The best designs were the simplest. Simplicity was not obtained without trial and error, and when it was achieved the solution, to the uninitiated, appeared obvious.

The illustrations of the evolution of the telephone gave an excellent example of the simple and most obvious-looking instrument being the best, and, incidentally, the most difficult to achieve.

The engineer needed the artist, and the artist was anxious to get into industry, but both of them needed conditioning if they were to get the best from each other.

How could this be achieved?

If co-operation on a worth-while national scale was to be organised, it must be a joint effort sponsored by such institutions as the Institution of Mechanical Engineers, in collaboration with the Federation of British Industries, the Council of Industrial Design, the Society of Industrial Artists, the Design in Industry Association, and technical and design colleges. It would have to develop from a small select body which would bring into being and staff a school of design instruction with an agreed syllabus, which, when taught, would be added to the existing training of the engineer and artist students at a late stage in their syllabus. There were so few knowledgeable specialists of the proper calibre available that a school of instruction was necessary to create the number of teachers required.

Mr. A. Whitaker said that over the whole range of human creative activities, practical or otherwise, there had never been entirely absent the consciousness of the importance of appearance.

The present paper was a sign that the value of appearance in engineering products was again being recognised, and the only gap in the paper had been filled by Mr. Holister's emphasis upon the importance of the team

element in engineering design. It was a fact that engineering design was becoming more and more a team activity. That was inevitable, but it presented a fundamental difficulty in that any form of artistic creation was not a team activity, but was essentially an individual activity. The combination of the two raised organisational difficulties which were not yet fully understood. The development of creative activities in a team was a peculiar aspect of modern engineering, and as techniques became more and more complicated, so the members of the team became more numerous and more specialised. Having got highly competent teams of technicians, there were two possible ways of imposing on the activities of the team what might be called (although he did not like the word) the æsthetic aspect of design.

One method was to introduce into the team people who had had the right sort of training and who could exercise in the team the influence necessary if the appearance of the product was to be improved. The difficulty, of course, was to get people of that type. The alternative was to superimpose upon the activities of the team some outside expert whom one might call a consultant designer. His own experience of trying to work both schemes was that in the long run what was wanted was a combination of the two.

(To be continued)

Technical Reports

Report on Standard Samples for Spectrochemical Analysis (Technical Publication No. 58B). American Society for Testing Materials, 1916, Race Street, Philadelphia 3, Pa., U.S.A. Price 1·25 dollars.—This comprehensive report, which should be of interest to all those interested in spectrochemical analysis, analytical chemistry and allied fields, provides in a form for ready reference current information on spectrochemical standard samples. It was compiled by Sub-Committee IV on Standards and Pure Materials of ASTM Committee E-2 on Emission Spectroscopy, and it extends and replaces information given in a publication prepared by Messrs. Brode and Scribner, issued by ASTM in 1944 and revised in 1947. The rapid growth of spectrochemical analysis and a corresponding increase in available standard samples call for a periodic compilation of types and sources of standards for the information of analysts. After an introduction describing the scope of the report, with definitions and nomenclature, there are listed in the form of extensive tables and data available standard samples on iron and steel, aluminium and its alloys, magnesium and its alloys, zinc, lead and tin alloys, and copper alloys. Miscellaneous standard samples include steel-making alloys, ores and ceramic materials; semi-quantitative standards, synthesised mixtures and solutions and electrode materials. The numbers of standard samples listed in the series of reports are as follows: 313 in 1944, 548 in 1947 and 752 in 1950. The section on pure materials lists 325 entries supplied by forty-three sources. The total number of entries of standard samples and pure substances in this report is 1077. Various organisations supplying the material are noted.

Flameproof Electrical Apparatus. Flange Gap Protection and Container Pressure with a Fourth Series of Industrial Atmospheres (Ref. G/T244). Compiled by A. P. Paton, B.Sc., A.M.I.Mech.E., A.M.I.E.E. The British Electrical and Allied Industries Research Association. Price 7s. 9d., post free.—Summarised results of the E.R.A.'s researches on flange gap protection for air filled flameproof electrical apparatus have already been published in Refs. G/T139, G/T167 and G/T183. These reports give data for thirty-one gases and vapours commonly met with in industry. Particulars for eight other gases contained in the present report complete the results arising from these researches, though similar work on the question of flanged protection for oil immersed gear continues and other work such as the study of the basic principles of intrinsic safety is being pursued. The main results given in the present report have been communicated to the British Standards Institution for use in connection with the revision and amendment of B.S.229.

Hydro-Electric Progress in Canada in 1950

THE increase in installed capacity of Canadian hydro-electric plants in 1950 was 1,037,275 h.p., a total that in the past has been closely approached only in 1943, when the Shipshaw plant was completed. A large proportion of this new capacity represents construction undertaken by the Hydro-Electric Power Commission of Ontario and particularly the near completion, well in advance of original schedule, of the Des Joachims project of 480,000 h.p. on the Ottawa River above Pembroke. Other moderate-sized plants and additions to capacity were well distributed across Canada, the largest being 130,000 h.p. in two new units at the La Trenche plant of the Shawinigan Water and Power Company on the St. Maurice River.

The total installed capacity of water-power plants in Canada is now 12,654,835 h.p., which represents the development of less than 23 per cent of total resources. New plants and extensions which are under active construction are tentatively rated at about 1,000,000 h.p. and those under preliminary construction or definitely planned total about 1,500,000 h.p. There are, as well, several sites of high capacity, which have been under investigation for possible development, on which it is probable that construction will be undertaken within a few years' time.

In the field of power distribution, construction was also very active in 1950. New main transmission lines were completed or were under construction in many sections of the country, new transformer and sub-stations were built and secondary lines were extended. Good progress in rural electrification was achieved, particularly in Ontario, Quebec and Manitoba.

During the year the demand for hydro-electric energy continued to expand throughout the country as a result of a high level of industrial activity (partly occasioned by the joint defence programme) in conjunction with increased commercial, domestic and rural consumption. The increased overall demand was reflected in the consumption of primary power, which, according to the records of the Dominion Bureau of Statistics for the first ten months of 1950, was over 8 per cent greater than in 1949. Supplemented by the capacity of new plants, production of power was, in general, keeping pace with the increased demand with the possible exception of southern Ontario, where a very rapid growth in load was creating difficulty in meeting all requirements.

British Columbia and Yukon Territory.—The British Columbia Power Commission made good progress on its initial development of 33,000 h.p. in two units at Whatshan Lake and operation was scheduled for April, 1951; ultimately the plant capacity may be doubled. The project involves a storage dam on the Whatshan River below the lake, a tunnel 2½ miles in length and a power house on the shores of Lower Arrow Lake. The Commission also has under construction a development at Clowhom Falls, on the Clowhom River at the head of Salmon Arm. The initial installation will consist of two units each of 2000 h.p., but the plant is being designed to allow for an expansion to at least 12,000 h.p. upon demand. The initial head is 130ft, which may be increased to 165ft by raising the dam. Surveys and investigations have also been completed covering a development on the Quesnel River.

The British Columbia Electric Railway Company, Ltd., has completed the installation of the third unit of 47,000 h.p. in the Ruskin power station. This unit has been installed primarily for peak-load purposes as water is not available for continuous operation. The Company has undertaken the modernisation of the Lake Buntzen No. 1 plant and will replace seven old units having a total capacity of 28,140 h.p. by one new unit rated at 70,000 h.p. At its Bridge River development the height of the La Joie storage dam has been raised to elevation 2405ft, which will provide storage capacity to the extent of 285,000 acre-feet. Design and fieldwork continued on the Jones Lake project, about 15 miles east of Chilliwack, a development of 80,000 h.p. in a single unit under 2000ft head. In the field of power distribution an extensive programme of substation construction was carried out in Vancouver, in the Fraser Valley, and on lower Vancouver Island.

The Aluminum Company of Canada, Ltd., continued its investigations on the Nechako-Kitimat project. Satisfactory sites were found for a main diversion dam on the Nechako River and for a feeder diversion from the Nanika River; under the proposed scheme the development of an estimated 1,600,000 h.p. of firm capacity is envisaged.

Alberta.—Calgary Power, Ltd., has completed a large part of its overall scheme, covering the Spray Lakes power and storage development and in December brought into operation the Spray plant of 62,000 h.p., a single unit under 900ft head. The scheme involves a main diversion and storage dam in Spray Canyon and a control dam in Goat Pass. At the latter the Three Sisters power station of 3600 h.p. is under construction for operation in June, 1951. Below the Spray power station the remaining drop to the Bow River near Canmore is being developed in the Rundle power station of 23,000 h.p., which is expected to be in operation by July, 1951. As the newly available storage provides a more dependable flow in the Bow River, an additional unit of 12,000 h.p. is being installed at Kananaskis for operation in 1951.

Manitoba.—Although somewhat delayed by flood conditions on the Winnipeg River throughout the spring and summer, good progress was achieved on the Pine Falls development of 114,000 h.p. by the Government of Manitoba. The dam has been partly completed and work is under way on the power house. It is anticipated that two units of 19,000 h.p. each will be ready for service late in 1951.

For the purpose of serving the Lynn Lake mining field, Sherritt-Gordon Mines is proceeding with a development of 7000 h.p. on the Laurie River, a tributary of the Churchill River in northern Manitoba. During 1950 an earth-fill storage dam with a concrete spillway was completed at the outlet of Russell Lake. During 1951 a second storage dam will be built upstream at the outlet of Eager Lake; construction will be commenced also on the power station, which is to be located about 14 miles below Russell Lake.

Ontario.—The largest project of the Hydro-Electric Power Commission of Ontario, at Des Joachims, has already been mentioned. The Chenaux generating station on the Ottawa River at Limerick Island, about 10 miles north of Renfrew, was also largely completed in 1950, the main dam, the auxiliary dams, the headworks and part of the power house being finished. The completed plant, consisting of eight units, will have a total installed capacity of 160,000 h.p.

A third site, on the Ottawa River, La Cave Rapids, about 7 miles above Mattawa, was being developed during the year. The east and west gravity walls of the main dam have been completed; also about 25 per cent of the headworks and power house. An essential part of this development is the construction of 37 miles of new railway to replace the existing section of the Canadian Pacific Railway from La Cave to Temiskaming, which will be flooded when the headwater is raised to operating level. The station will have an initial installation of six units with a total capacity of 192,000 h.p. and provision is being made

for the installation of two additional units.

The development of the "Tunnel" site on the Mississagi River, near Thessalon, was completed and the two units in the power station commenced operation in July. The station has a total installed capacity of 56,000 h.p. The initial stage of Pine Portage project, which is on the Nipigon River, went into operation on July 5, 1950, and the second, on September 15, 1950. The two units have a combined capacity of 80,000 h.p. Provision has been made for an additional two units, which would give the plant an ultimate capacity of 160,000 h.p.

The Niagara Diversion Treaty having been ratified by the Governments of Canada and the United States, the Commission is planning to undertake a new development on the Niagara River. Preliminary planning and foundation investigations are well under way. The new project will have a total installed capacity of 600,000 h.p. in six units. It is scheduled for operation in 1954.

In the Southern Ontario system good initial progress has been made on the huge task of changing the distribution in this area from 25-cycle power to that of the standard 60 cycles. It will take several years to complete the work involved.

Quebec.—Two new units, each of 55,000 h.p., were brought into operation in December, at Beauharnois, St. Lawrence River, by the Quebec Hydro-Electric Commission. The power house building has been completed and four additional units will be installed during 1951; ultimate capacity is 600,000 h.p. and dredging operations in the intake canal are being continued to provide the necessary diversion capacity. In the Temiscamingue-Abitibi district the Commission is completing surveys for a development on the Upper Ottawa River.

The Shawinigan Water and Power Company made particularly rapid progress in the construction of its new power development at La Trenche Rapids on the St. Maurice River. Two units each of 65,000 h.p. went into service late in December and an additional three units are expected to be in operation by the early summer of 1951. The project is designed for an ultimate capacity of 390,000 h.p.

The Aluminum Company of Canada has commenced preliminary construction work on a 200,000 h.p. development on the Peribonka River at Chute-du-Diable, which will operate under a head of 110ft. It will be tied in with the Saguenay system by means of a double-circuit, 154kV transmission line about 17 miles long, terminating at Isle Maligne. The first unit of 50,000 h.p. is expected to be put in service in May, 1952, and the remaining three units later in the same year. The Company is also contemplating the construction of a second development of 200,000 h.p. on the Peribonka River, at Savanna Falls, a few miles below Chute-du-Diable.

The Lower St. Lawrence Power Company is planning the construction of a new plant of about 10,000 h.p. capacity on the Mitis River, near Ste. Angele de Merici, but only preliminary survey work has been carried out to date.

The Quebec North Shore Paper Company is undertaking the construction of a power station near the mouth of the Manicouagan River. It is being designed for an ultimate installation of six units of 56,000 h.p. each, under 124ft head, but the initial installation of one unit for 1952 operation will be at lower head.

The Labrador Mining and Exploration Company, Ltd., has under consideration the development of the Menihek Rapids on the Ashuanipi River, in the Labrador district, with an initial installed capacity of 15,000 h.p. Studies are also being made on the Ste. Marguerite River for the development of hydro-electric power for the use of the Quebec North Shore and Labrador Railway Company at Seven Islands; the proposed initial installed capacity is 7000 h.p.

The Quebec Streams Commission successfully maintained the desired regulation of flow on controlled rivers of the Province of Quebec through its extensive system of storage reservoirs in various parts of the province, namely, on the St. Maurice, St. Francois, Gatineau, Lievre, Mitis, du Loup, and North Rivers, and in Lake Kenogami. Preliminary studies of prospective water power developments have been completed on the Manicouagan, Moisie and Kaniapiskau Rivers on the North Shore, and continued on the Bell River, in the mining district of Abitibi, and on the Madeleine River, in the Gaspe Peninsula. River profiles were determined on the Bell River between Kiask Falls and Lake Mattagami, on the Waswanipi River, between Lake Mattagami and Lake Opawica, on the Moisie River, and on the Kaniapiskau River.

Atlantic Provinces.—In Nova Scotia, the Nova Scotia Power Commission in October completed its 12,800 h.p. development, in two units, on the Mersey River at Deep Brook. The Commission has recently begun construction on an 8500 h.p. plant on the Bear River at tidewater, which will operate under 250ft gross head.

The Nova Scotia Light and Power Company brought into operation in September its new Paradise Brook development of 5000 h.p. under 500ft head. The Company is also constructing for operation in 1951 a new power station of 4000 h.p. at White Rock on the Gaspereau River, which will operate at 62ft head and will replace an older plant of 1105 h.p. at 32ft head.

The New Brunswick Electric Power Commission has undertaken a development of 27,000 h.p. at "The Narrows," on the Tobique River near its mouth, with operation expected in 1953. The main dam will create a head-pond 10 miles in length and necessitate highway and railway relocation. Some storage is being obtained on five small lakes in the headwaters but the plant will be operated largely on a run-of-river basis. The Newfoundland Light and Power Company, serving principally St. John's and Bell Island, has practically completed its new development of 13,000 h.p. on the Mobile River.

Diesel-Electric Shunting Locomotive for Steel Works

For some seventy-five years W. G. Bagnall, Ltd., has specialised in the design and construction of steam locomotives at the Castle Engine Works at Stafford, and during that time more than 3000 engines have been built. A short while ago, in association with the Brush Electrical Engineering Company, Ltd., and Mirrlees, Bickerton and Day, Ltd., the firm started building diesel-electric locomotives, and a new company, Brush Bagnall Traction, Ltd., was formed to co-ordinate the work of the three companies. Recently the first unit to be built under the new arrangement, a diesel-electric shunting locomotive for the Steel Company of Wales, was completed at the Castle Engine Works. This locomotive, one of a batch of four similar units, is of the 0-6-0 type, designed for a maximum tractive effort of 32,000 lb, a tractive effort at one-hour rating of 18,600 lb and a continuous tractive effort of 15,100 lb. At the one-hour rating the speed is 7·2 miles an hour, and at the continuous rating it is 8·3 miles an hour, its maximum safe speed being 20 miles an hour.

The locomotive, which we illustrate below, has been specially designed for the arduous work encountered in a steel works, and for this reason the main frames and buffer beams are of particularly heavy construction. It has a Mirrlees six-cylinder, four-stroke, cold-starting engine, fitted with a Buchi exhaust gas turbo-charger. The engine is rated at 480 b.h.p. for twelve hours at 720 r.p.m. and 528 b.h.p. for one hour at 720 r.p.m. Directly coupled to the engine is the main generator which has six poles, with separately excited and self-excited shunt windings and a differential series winding. An auxiliary generator (a four-pole shunt-wound interpolar machine) is mounted on a sliding base on top of the main generator, and multi-belt driven from the main generator armature.

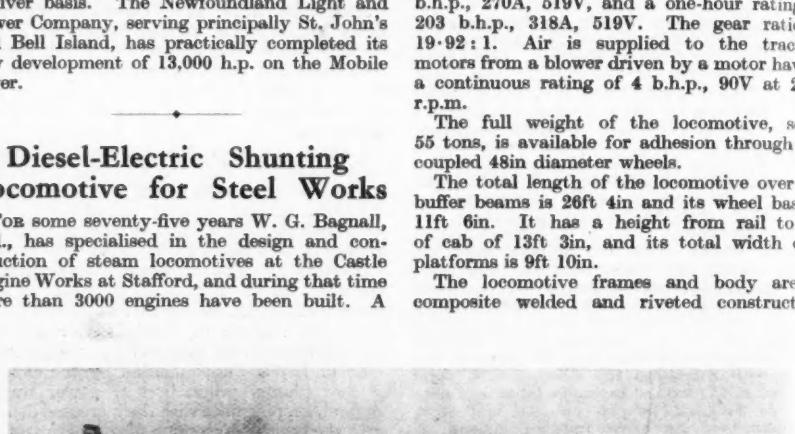
The continuous rating of the main generator is 280kW, 519V, 540A at 720 r.p.m., and the continuous rating of the auxiliary generator 10kW, 90V, 111A at 820/1970 r.p.m.

The current from the generator is supplied to two traction motors mounted on the outer axles of the locomotive. These traction motors, which are nose-suspended, drive the axles through double reduction gearing, and each has a continuous rating of 174 b.h.p., 270A, 519V, and a one-hour rating of 203 b.h.p., 318A, 519V. The gear ratio is 19·92 : 1. Air is supplied to the traction motors from a blower driven by a motor having a continuous rating of 4 b.h.p., 90V at 2000 r.p.m.

The full weight of the locomotive, some 55 tons, is available for adhesion through the coupled 48in diameter wheels.

The total length of the locomotive over the buffer beams is 26ft 4in and its wheel base is 11ft 6in. It has a height from rail to top of cab of 13ft 3in, and its total width over platforms is 9ft 10in.

The locomotive frames and body are of composite welded and riveted construction, the main frames being manufactured from 1½in thick steel plate. Brackets can be fitted to the 3in thick buffer beams for lifting the locomotive by means of jacks at all four corners. The engine and generator compartment flooring are formed out of continuous plates ⅛in thick without any pockets. Manganese steel liners



DIESEL-ELECTRIC SHUNTING LOCOMOTIVE

are fitted to the axleboxes and axlebox guides.

The superstructure is divided into three main compartments—radiator compartment, engine compartment and generator compartment—and a bulkhead between the engine and generator compartments keeps the fumes from the engine out of the generator compartment. The doors in the generator compartment sides are fitted with Visco oil-wetted filters to ensure a supply of clean filtered air to the main and auxiliary generators, and also to the motor-driven traction motor blower.

The radiator compartment houses the elements for water and lubricating oil cooling, together with the fan runner, which is driven by means of multi-belts from a shaft extension coupled to the main engine crankshaft by a flexible coupling. The radiator elements at the front are protected from possible heat transfer from hot metal cars by insulated doors set in front of the elements. Air for cooling the radiator is drawn through the body sides, and after passing through the elements is expelled through openings in the roof.

The locomotive has a Westinghouse air brake equipment, the cylinders operating double blocks on the leading faces of all wheels. A hand brake is also fitted. A motor-driven compressor supplies air for the brake, sanding, warning horn and window wipers, and, in addition, there is an air supply for the operation of brake cylinders on dump cars, which the locomotive will, on occasion, have to haul.

The locomotive is provided with a large comfortable cab, in which the controls are duplicated on each side and in which the driver will be fully protected from the heat radiating from hot metal when hauling ladle cars. All working parts and control gear on the locomotive are easily accessible through large hinged panels for maintenance and inspection purposes.

It is of interest to note that, in addition to these four diesel-electric shunting engines, the company is also building for the same customer three steam shunting locomotives, which incorporate most of the latest developments in steam practice. The use of the two types of motive power, both of the latest design, in the same industrial establishment should provide at some later date very interesting figures of comparative working costs and efficiency.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

DIMENSIONS OF UNSCREENED CAMSHAFT SPEED MAGNETOS

No. 1644 : 1950. This British Standard forms one of a series relating to magnetos, dynamos and similar units for internal combustion engines. It deals only with the dimensions of unscreened, camshaft-speed magnetos (combined with distributor head) having shank and spigot mountings. The dimensions included are those necessary to ensure interchangeability. The figures included are of typical magnetos and do not purport to represent standard designs or methods of locking the distributor head in position. Price 2s. 6d.

ELECTRICALLY-DRIVEN POINT-OPERATING MACHINES FOR RAILWAYS

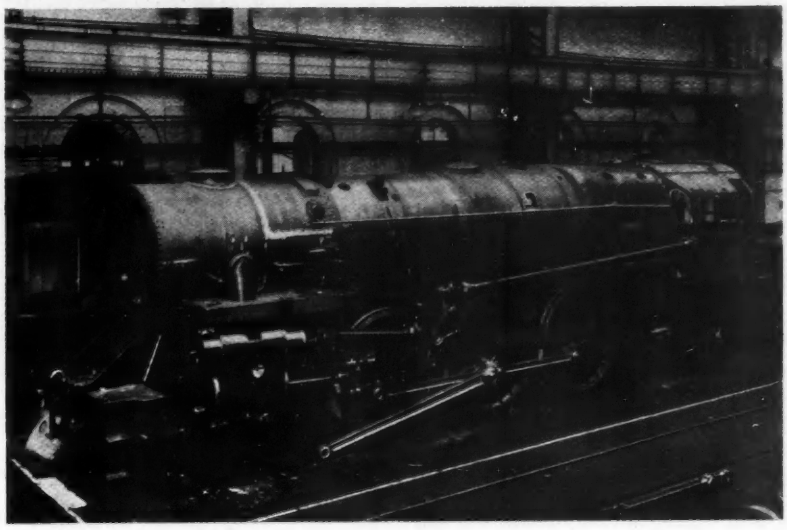
No. 581 : 1950. This standard is a revision of the 1934 edition. It covers electrically-driven machines for operating railway points, derailers, movable diamonds and facing-point or fouling bars. The main amendments in the present revision are as follows: hand-generator machines are recognised as a standard type; the low-speed, low-voltage machine is no longer recognised as standard. The standard has been enlarged to cover different performance requirements for identical machines required for use with both bull-head and flat-bottom switches; for the latter condition the voltage rating for low voltage machines is increased from 30V to 40V. An insulation resistance test is now specified as a routine test.

The standard lays down the sequence of operations and the standard voltages; it gives requirement for general construction and protection from weather, for the motor, wiring and terminals, for manual operation and for performance. The information to be given by purchasers and suppliers is stated in appendices. Price 2s.

Standard British Mixed Traffic Locomotive No. 70,000

No. II—*(Continued from page 164, February 2nd)*

IN our last issue we gave some general notes on the first standard 4-6-2 mixed traffic locomotive built by British Railways, and in what follows, we deal with some of the points of its design. In a Supplement which accompanies this issue drawings of the locomotive and its tender are reproduced and in the accompanying engravings the locomotive is shown in course of construction at Crewe Works.

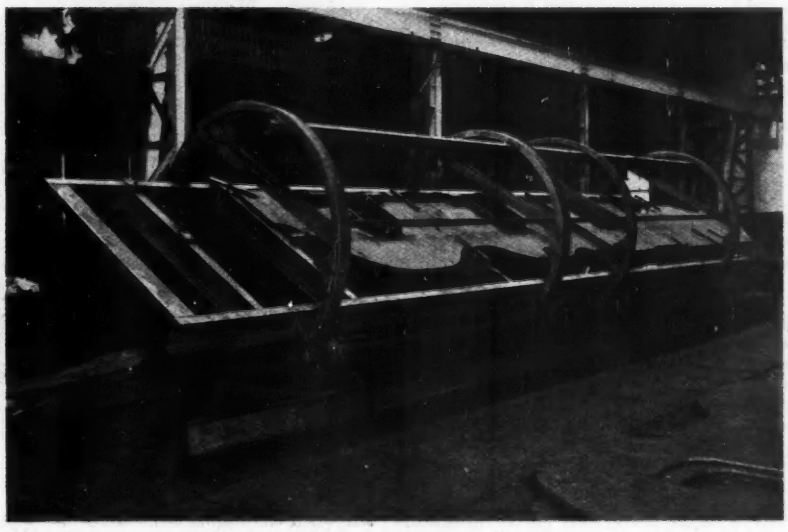


ENGINE UNDER CONSTRUCTION

The main frames of the locomotive are of 1¼in thick steel plates, spaced 3ft 2½in apart, with the centre lines coinciding with the centre of the axlebox guide faces. Fabrication has been widely adopted in the construction of the frames, and in one of the photographs can be seen one of the manipulators used in the manufacture of the frame. In this manipulator the axlebox guides are welded integrally with the frame plates. These guides are fitted with manganese liners. The frames are well braced by vertical and horizontal stretchers and by pin-jointed cross stays attached to the horn plates. Two of the vertical stretchers support the front of the boiler barrel and the firebox front on adjusted brass wearing liners. The back of the firebox is carried on brackets on a rear end extension to the main frames. This rear end frame extension consists of two 2in thick slabs riveted to the main plates behind the trailing coupled wheels. A single draw-bar transmits the tractive effort to the tender through rubber springs.

Manganese steel liners are welded to the faces of the axleboxes which are in contact with the horn guides. Both the engine and the tender are carried on Timken self-aligning roller bearing axleboxes, non-split cannon type boxes being fitted to the bogie and coupled axles of the engine.

Laminated springs with carbon steel leaves, fitted to both engine and tender, are secured in their spring buckles by a vertical central rivet. The coupled axle springs have a span of 4ft when loaded and they are fitted with under-



MANIPULATOR FOR MAIN FRAME

hung spring brackets with rubber damping pads and hangers in tension. These hangers are solid with cotters at the top and bottom ends, adjustment being obtained by fitting cotters of suitable depths.

The boiler, which has a working pressure of 250 lb per square inch, is of normal design and has riveted joints throughout. Its shell is of high-tensile manganese steel. The second of the two rings forming the boiler barrel is tapered to form a true cone. These two rings, which are rolled from $^{19}/_{32}$in and $^{21}/_{32}$in thick plate respectively, have outside diameters of 5ft 9in at the front and 6ft 5½in at the firebox end. A drumhead smokebox tube plate is ¾in thick and the length between the tube plates is 17ft. A "Melesco" centrifugal drier in the steam dome separates water from the steam before it enters the steam pipe.

A multi-valve regulator by the Superheater Company is incorporated in the super-heater header fitted in the smokebox. Access is given to the regulator valves through a detachable cover in the top of the smokebox. Water is fed to the boiler through two separate clack valves placed at approximately 30 deg. on each side of the vertical centre line of the front barrel. These clack valves deliver on to two inclined trays, which deflect the incoming water round the inside of the barrel clear of the tubes. A steam manifold fitted on the top of the firebox in front of the cab is provided with separate shut-off cocks to each steam supply pipe as well as a main shut-off valve, which is operated from inside the cab. Two direct loaded safety valves are mounted on the hind barrel immediately behind the dome.

A "Belpaire" firebox with a wide grate is 7ft long outside, the width tapering from 7ft 9in at the front to 7ft 4in at the back, giving a grate area of 42 square feet. The steel wrapper plate is ½in thick and an inner firebox of copper has a ⅜in thick wrapper plate. The front of the firebox is extended into the boiler barrel to form a combustion chamber having a 1in thick tube plate. All firebox water space stays are of Monel metal, fitted with steel nuts inside the firebox. The firebox roof, longitudinal and transverse stays are of steel, the roof stays being riveted over on the outside of the steel wrapper.

A rocking grate fitted to the locomotive consists of twelve rocking sections, six on each side of the centre line. In each rocking section there are fourteen renewable firebar units, making 168 units for the whole grate. The two sides of the grate can be rocked separately from the footplate, the operating gear being so arranged that two different travels can be employed, i.e., full travel for dropping the fire when the engine is over an ashpit and a shorter travel for agitating the fire to eliminate ash and break up clinker while the engine is on the road. The ashpan has three hoppers, one between and one each side of the main frames. The ashpan is self-emptying, having bottom flap doors on the hoppers, connected by a shaft with universal joints and operated by a lever at ground level. Front damper doors on each hopper are opened and closed by screw gear worked from a hand wheel on the fireman's side of the cab. This gear is designed to allow fine adjustments to the air opening to be obtained. Two small doors are provided at the back of the firebox for cleaning purposes.

The cylindrical smokebox, which rests in a fabricated saddle, is "self-cleaning" having plates and a wire mesh grid arranged to prevent accumulation of ash in the box when the engine is working. Mounted on the right-hand side of the smokebox is a tri-tone chime whistle, made by the Crosby Valve and Engineering Company. This whistle is operated from the cab by a flexible cable passing down the handrail along the boiler.

In this locomotive the use of two cylinders with a wide firebox, which has been unusual in British practice since Ivatt's "Atlantic" of 1903, demonstrates the policy of the designers of the engine to combine mechanical simplicity with the largest possible steam generating capacity. The two 20in by 28in cylinders are steel castings fitted with cast iron liners in both the barrel and valve chest. Piston valves, 11in diameter, have a steam lap of 1 $^{11}/_{16}$in and a lead of ¼in; they are operated through conventional Walschaerts gear giving a travel in full gear of 7½in and a full gear cut-off of 78 per cent. Three-bar slide bars are fitted with an underhung crosshead.

Lubrication of the motion pins is by means of grease nipples and a gun, the nipples for the reversing shaft and expansion link being grouped together on the motion bracket. Valve and cylinder lubrication is by atomised oil delivered by mechanical lubricators supplied by the Gulf Oil Company (Great Britain), Ltd.

A bronze spring-loaded slipper incorporated in each piston head is designed to carry the heads clear of the cylinder barrel liners. Steam-operated cylinder cocks of large diameter are fitted for quick draining of the cylinders of any water which may accumulate in them.

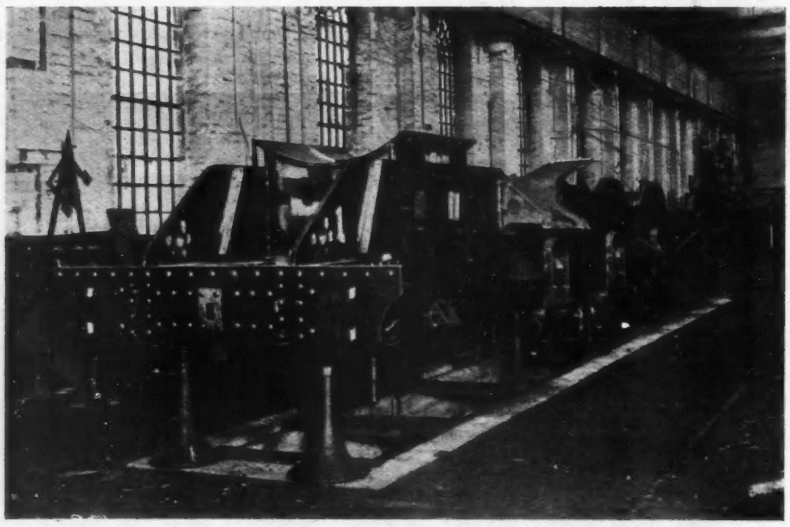
Reversing is by hand wheel and a screw at the reversing shaft lever, rotated by a tubular shaft from the cab. A drum type cut-off indicator is provided by the operating wheel, which is placed parallel to the longitudinal centre line of the engine.

The coupled wheels, which are 6ft 2in diameter on the treads, have their tyres shrunk on and secured by two small lips, one each side of the wheel centre. No separate securing ring, studs or rivets are used. Built-up weights in the wheels balance the revolving and 40 per cent of the reciprocating weight.

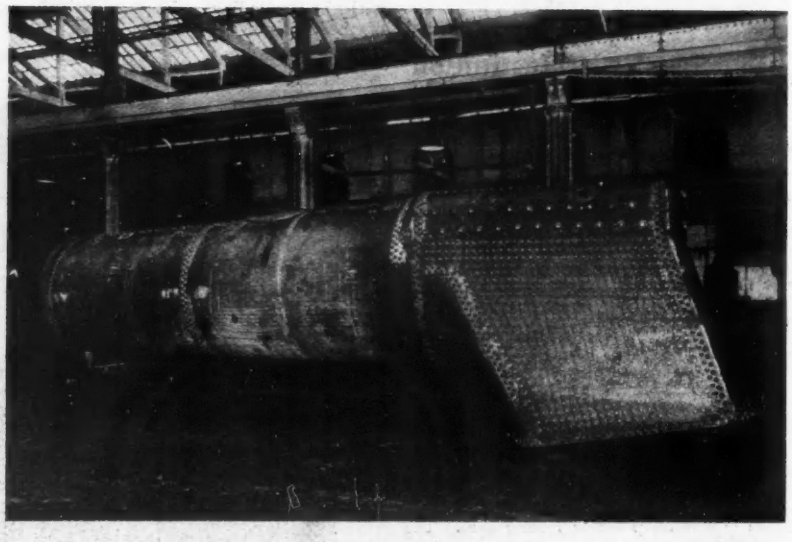
The bogie, which has four wheels of 3ft diameter on tread, is carried on Timken roller bearing axleboxes of the non-split cannon type. The engine weight is carried by side bolsters and laminated springs fitted in compensating beams. Side play control of the bogie is effected by means of double coil springs.

The pony truck has wheels 3ft 3½in diameter on tread and it is fitted with Timken roller bearings running in outside axleboxes. The engine weight is taken at three points on the pony truck frame, which is shown in one of our illustrations. One of the weight suspension points is at the pivot centre of the pony truck the other two being on bolsters sliding on pads on the truck frame and situated behind the centre line of the axle. Side play on the pony truck is controlled by coil springs.

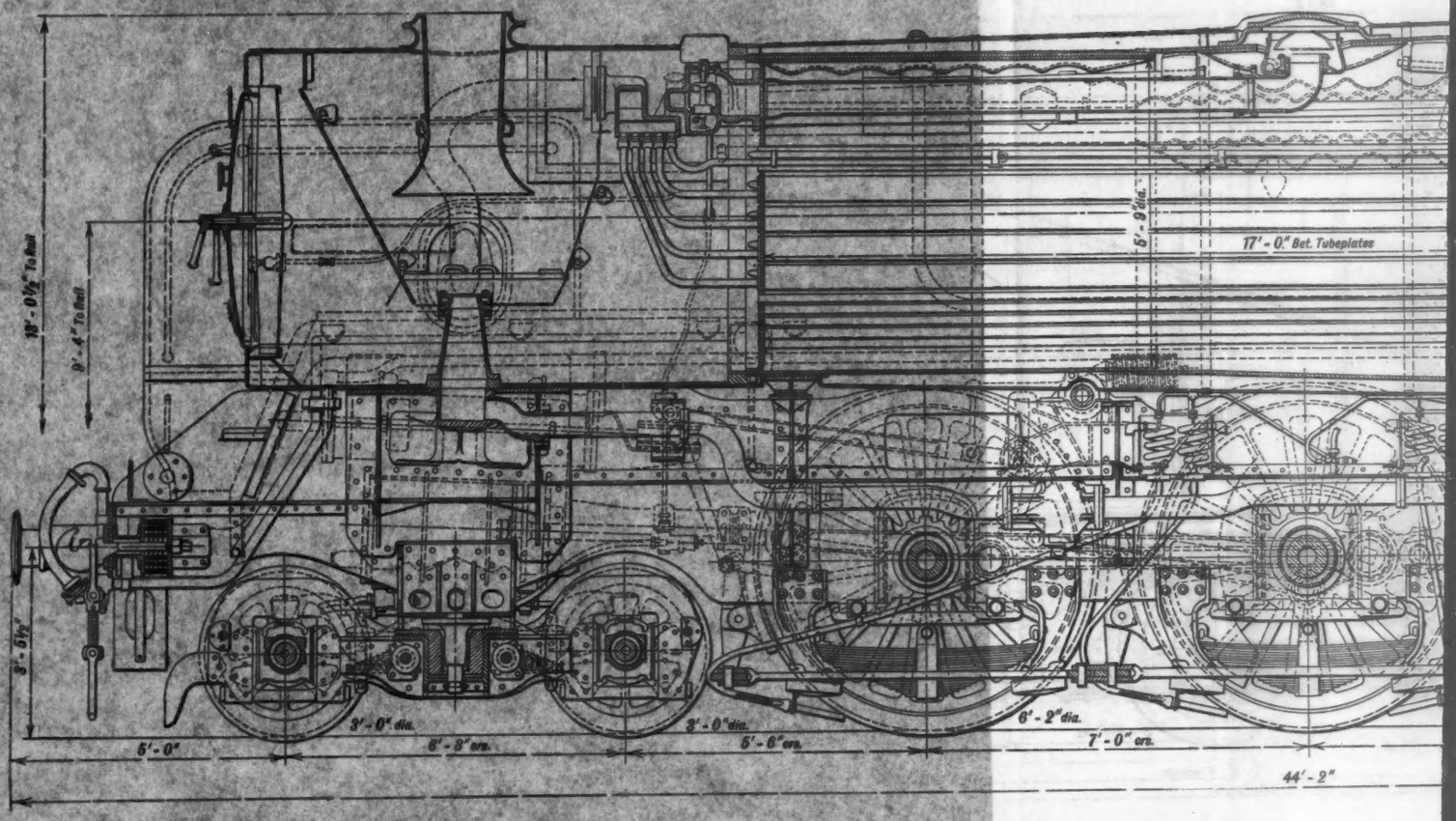
The cab structure is carried by cantilever supports attached to the firebox back plate and by a diaphragm plate at the dragbox, this arrangement allowing full freedom for the cab to move with the boiler as expansion takes place. All boiler fittings and pipes are kept free from the main frames to avoid differential expansion and secure freedom from fracture due to this cause. For this reason the exhaust

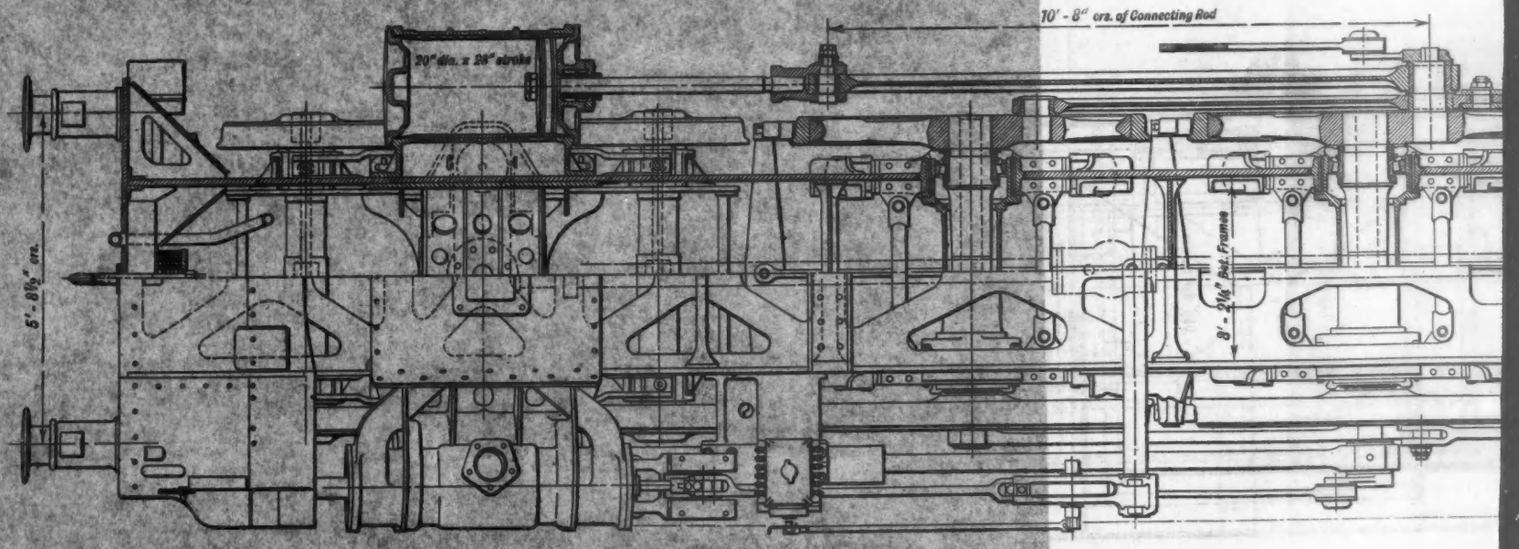


MAIN FRAME ASSEMBLY

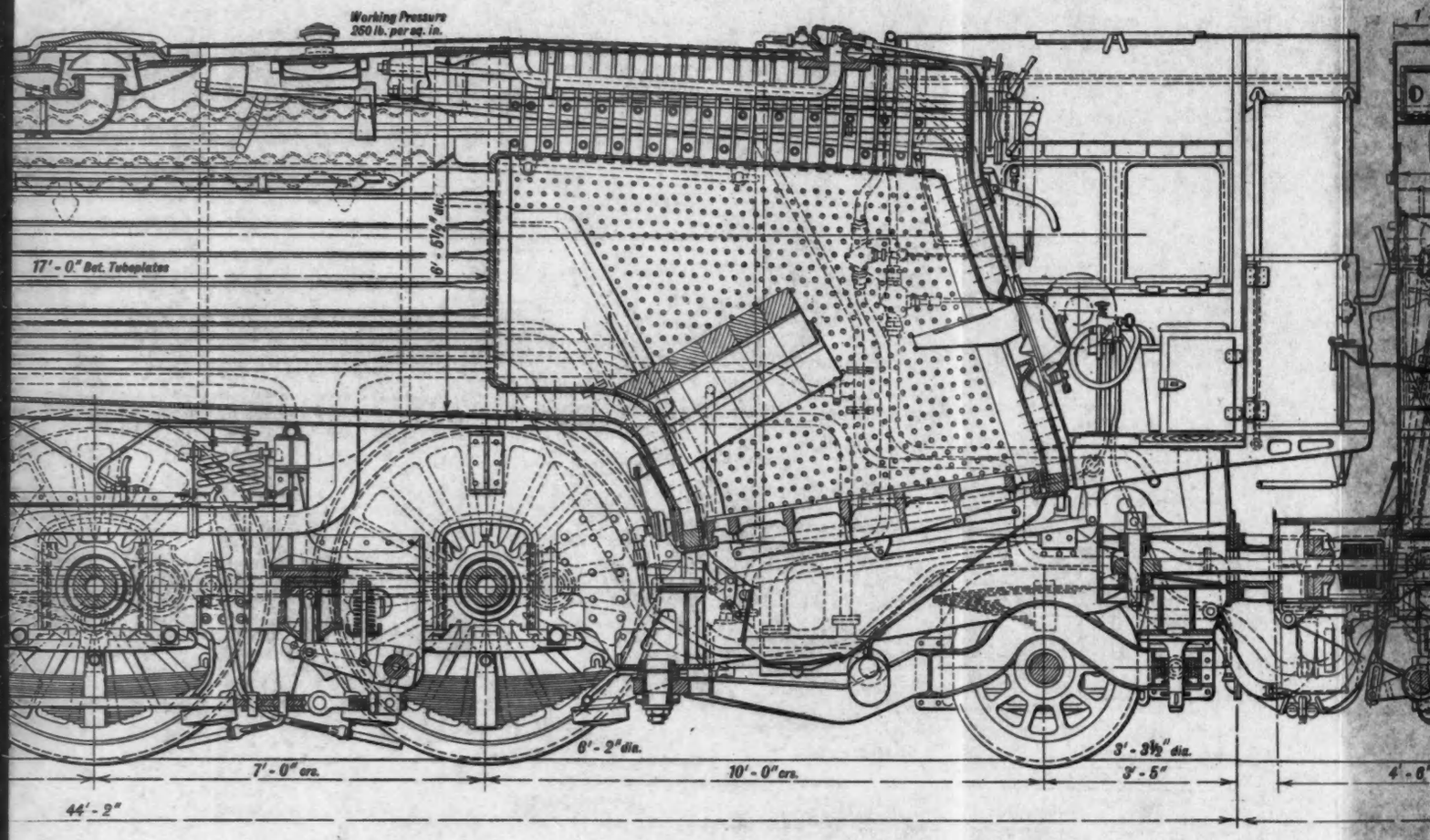


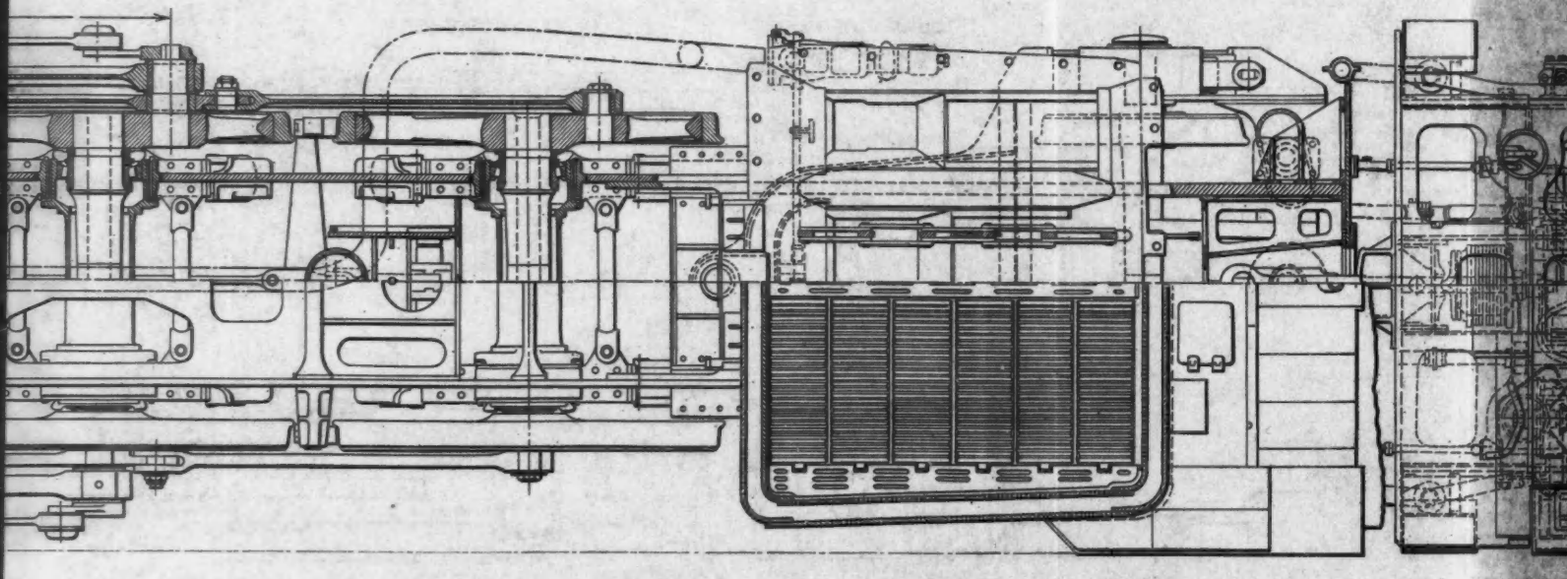
BOILER BEFORE MOUNTING


13' - 0½" To Rail
9' - 4" To Rail
3' - 5½"
5' - 0"
3' - 0" dia.
6' - 3" crs.
3' - 0" dia.
5' - 6" crs.
6' - 2" dia.
7' - 0" crs.
44' - 2"
5' - 9" dia.
17' - 0" Bet. Tubeplates


10' - 8" crs. of Connecting Rod
20" dia. x 28" stroke
5' - 8½" crs.
8' - 2½" Bet. Frames

STANDARD 4-6-2 MIXED TRAFFIC LOCOMOTIV





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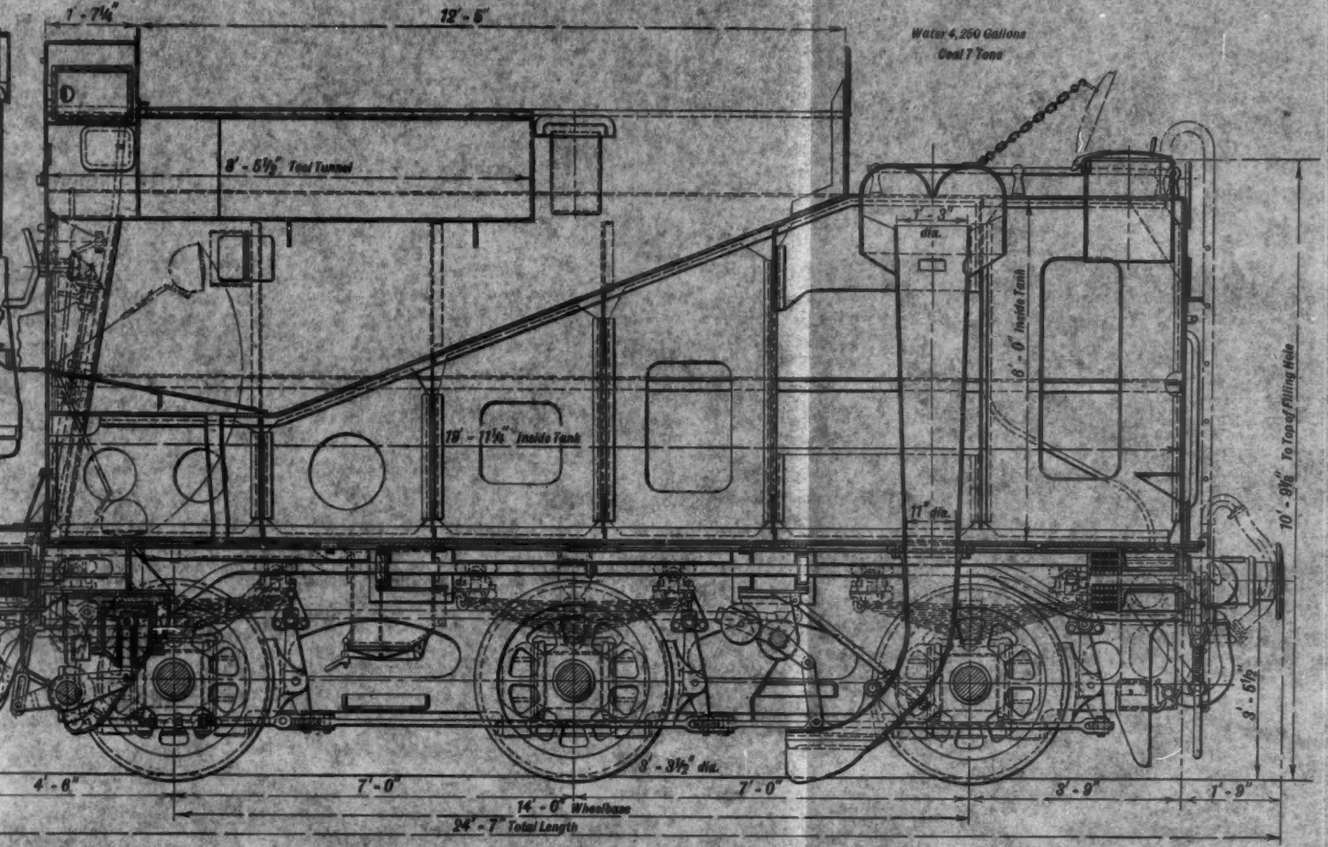
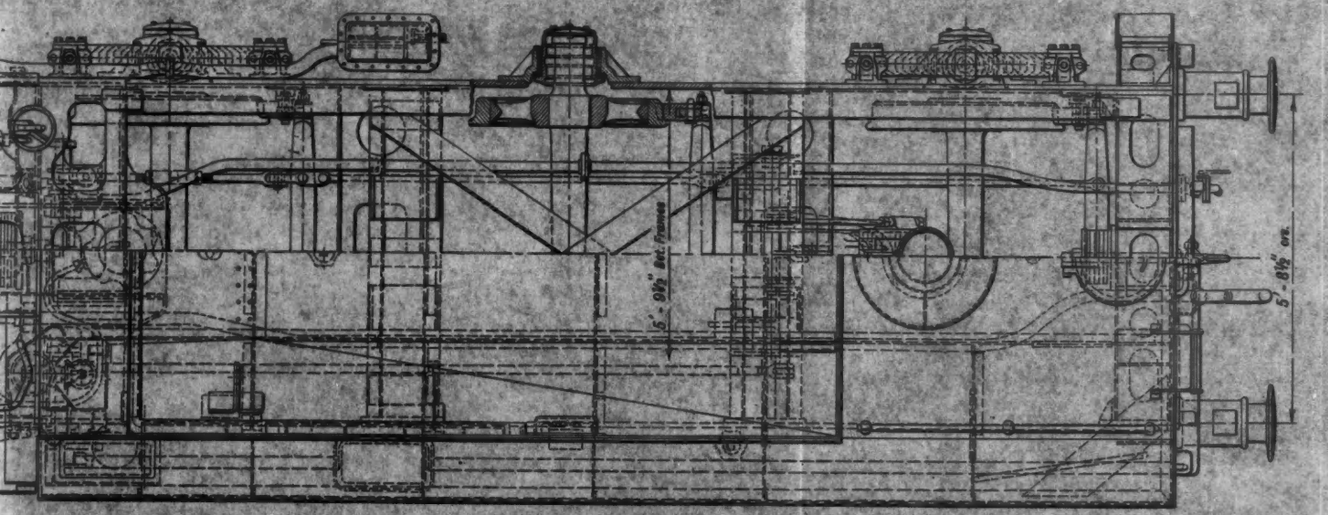
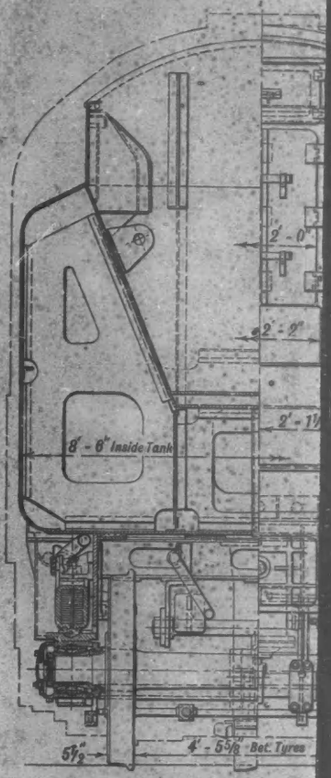
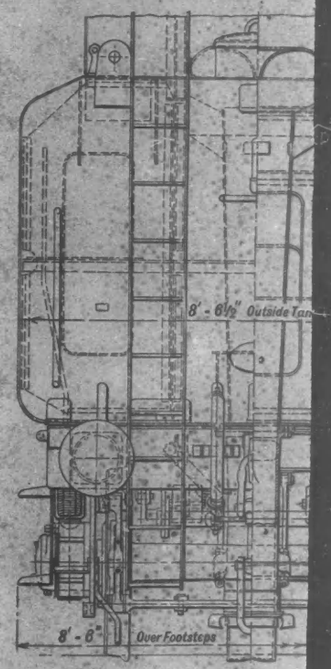
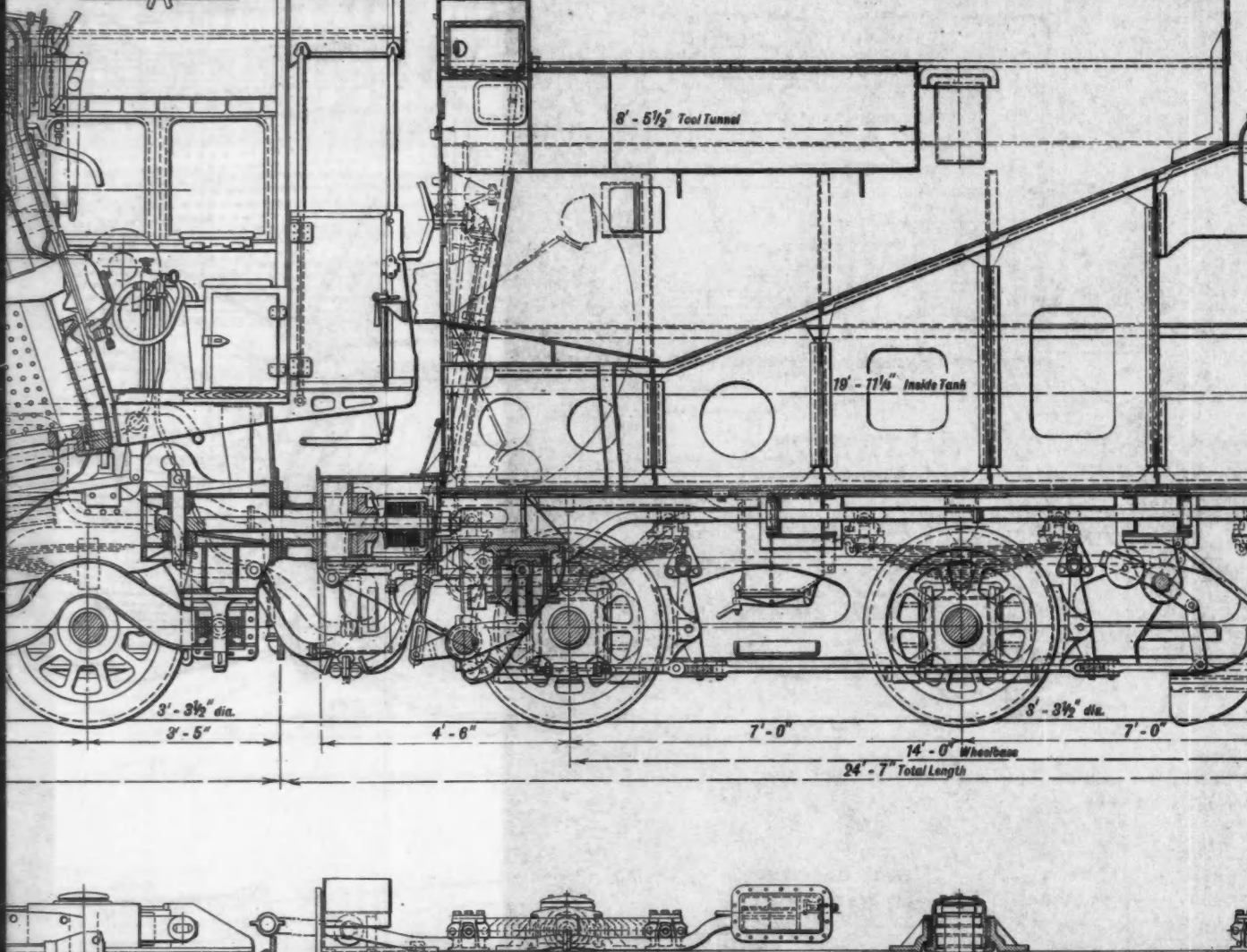


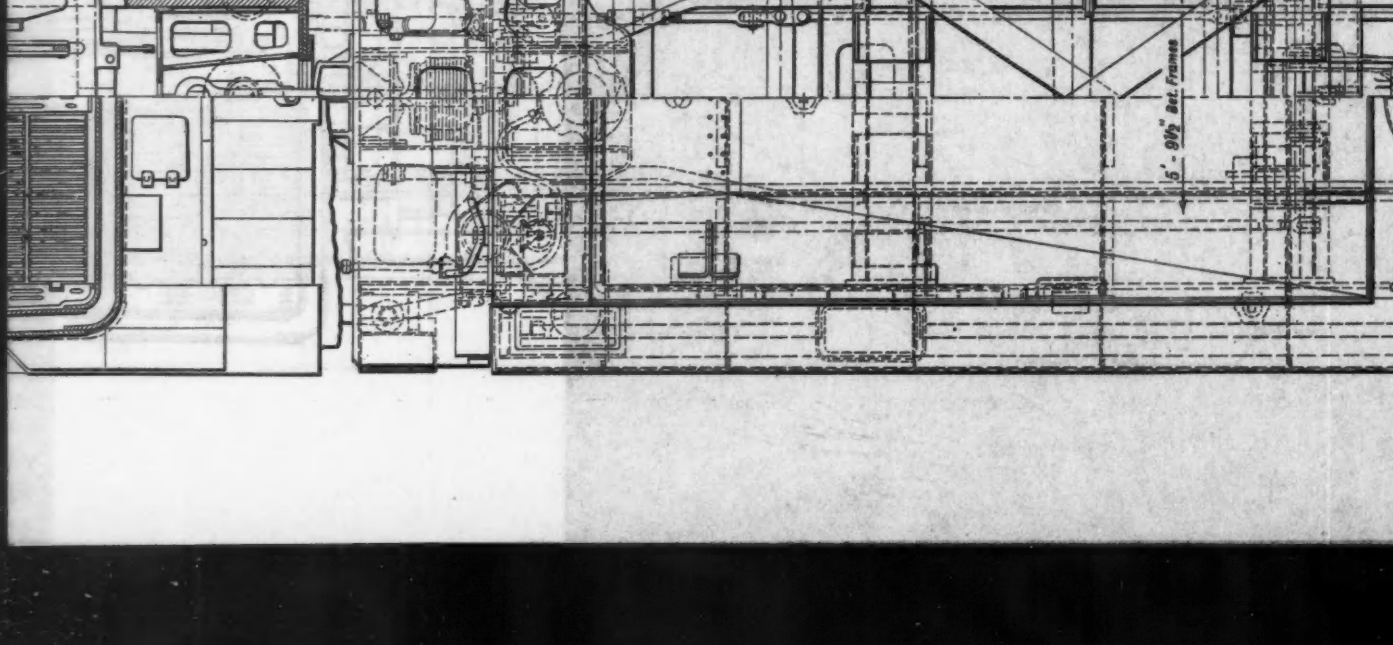


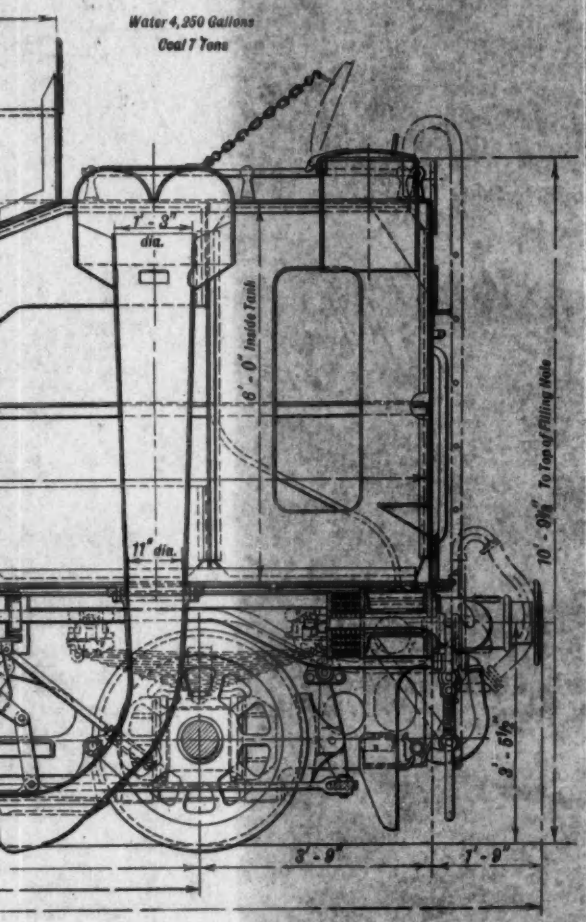


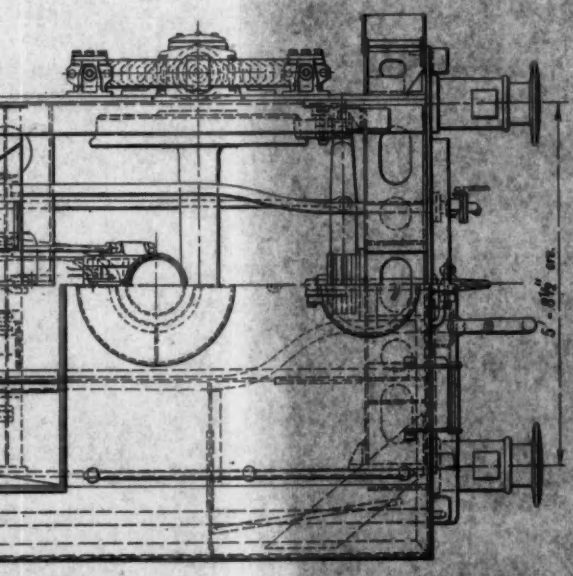


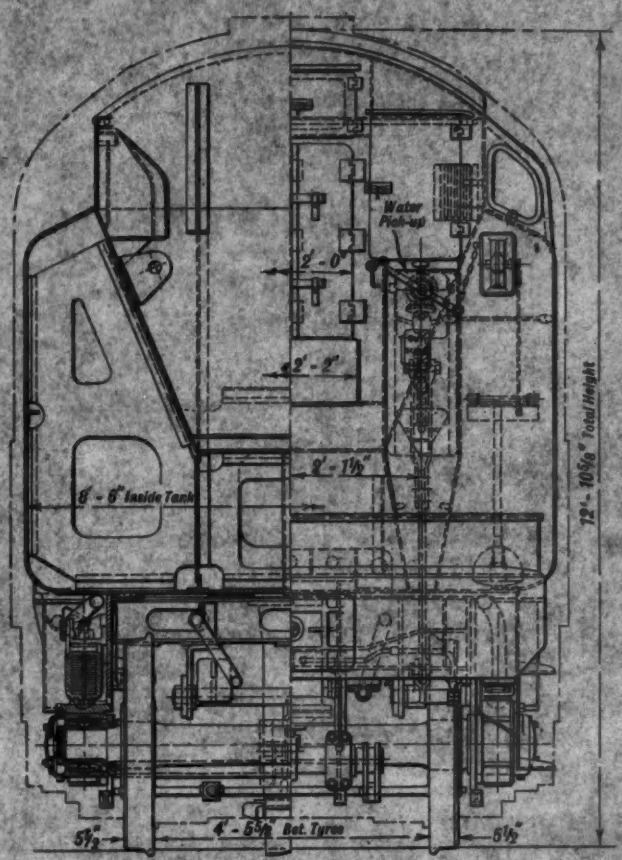
AFFIC LOCOMOTIVE No. 70,000

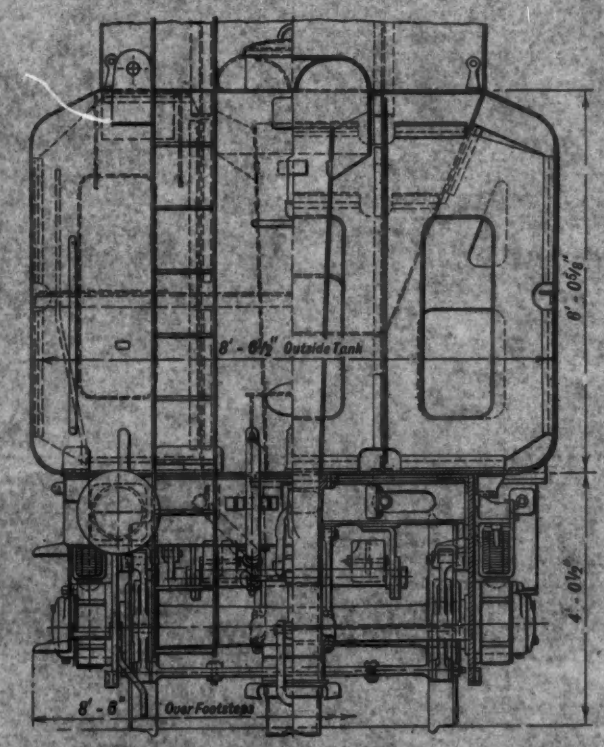





Water 4,250 Gallons
Coal 7 Tons
1' - 3" dia.
6' - 0" Inside Tank
11" dia.
10' - 9⅛" To Top of Filling Hole
3' - 5½"
8' - 9"
7' - 9"


5' - 3½" ors.


Water Pick-up
2' - 0"
2' - 2"
2' - 1½"
8' - 6" Inside Tank
12'- 10⅝" Total Height
5½"
4' - 5½" Bet. Tyres
5½"

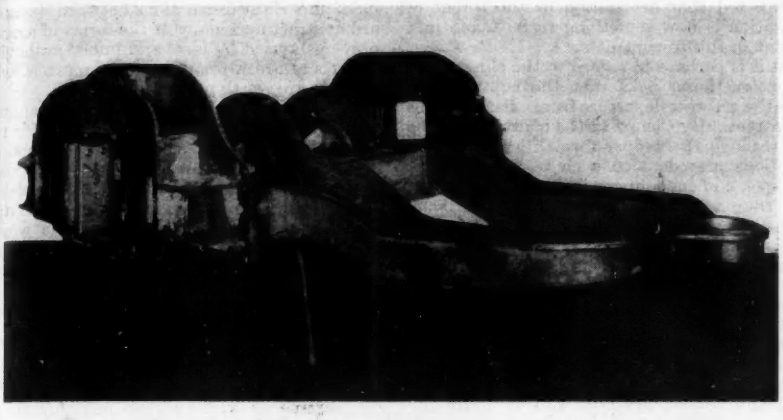

8' - 6½" Outside Tank
6' - 0⅝"
4' - 0½"
8' - 6" Over Footsteps

injector on the right-hand side and the live steam injector on the left are carried on brackets attached to the ashpan and foundation ring. The steam and water controls for both injectors are operated from the fireman's side of the engine.

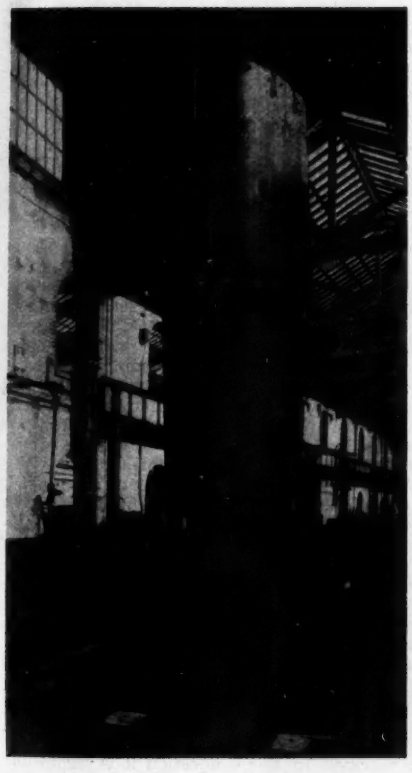
The cab floor plate is extended backwards to form a solid platform for the crew up to the front plate of the tender. The normal hinged fall plate is dispensed with and no footplate is required on the tender.

All the driver's controls are grouped to give easy access and operation, the vacuum brake, sanding and blower valves being carried on a control column at the driver's right hand. A leather upholstered seat and back are fitted on the driver's side, and side windscreens are provided outside the cab for the use of both driver and fireman.

Steam-operated sanding gear is fitted and supplies sand to the front of all coupled wheels and the rear of the driving wheels.



TRAILING TRUCK FRAME



RIVETING OF BOILER BARREL

TENDER

The tender is carried on six wheels of 3ft 3½in diameter. It has a welded tank with large radius corners, which facilitated the welding of the plates. The rectangular coal bunker is narrower than the tank.

Two external feed water sieve boxes are provided to collect dirt and foreign matter from water before passing to the injectors, the sieve element being arranged for easy withdrawal for cleaning or renewal purposes. Water pick-up gear is provided.

The wheels, axle and axlebox assembly for the tender is similar to that for the pony truck of the engine, and its water and coal capacities are 4250 gallons and 7 tons respectively.

The engine and tender have steam brakes, which can be worked independently or in conjunction with the vacuum brake by means of a separate driver's valve. Single type brake blocks operate on the six coupled wheels and all tender wheels.

In addition to the equipment used on the locomotive, which was supplied by the specialist firms already mentioned in our description, the following items were supplied by other manufacturers:—exhaust steam injector, by Davies and Metcalfe, Ltd.; vacuum brake ejector, driver's brake valve, steam brake valve and associated brake details, by Gresham and Craven, Ltd.; self-aligning ball bearings for valve gear return cranks, by Skefko Ball Bearing Company, Ltd.; buffers, by Turton Platts Company, Ltd.; fibreglass insulating mattresses for boiler and firebox, by W. Gilmour Smith and Co., Ltd.; manually operated boiler blowdown valve, by the Everlasting Valve Company, Ltd.; and the superheater, regulator valves and tangential steam drier, by the Superheater Company, Ltd.

South African Irrigation Scheme

GOOD progress is being made with preliminary work on a large irrigation scheme in South Africa which is estimated to cost about £17,500,000. The scheme will entail the diversion of the Orange River into the Great Fish River through a tunnel 50 miles long between the mountains dividing the catchment areas of the two rivers. Over half of the total expenditure will be accounted for by the tunnel which, it is estimated, will divert for conservation 1,000,000 acre-feet of water annually.

The water will be led to the tunnel by about 5 miles of canal starting just north of Venterstad. The bulk of the water will be passed down the Theebus Spruit into the Great Brak River and then to an existing dam at Grassride. Water for the lower Sundays River will be passed down the Fish River and will then be conveyed by a canal and a short tunnel to the Little Fish River, entering it just below Somerset East. The water will thence be passed to Lake Mentz for storage.

Conditions of Contract for Civil Engineering Construction*

By E. J. RIMMER, A.M.I.C.E., Barrister-at-Law

PRIOR to 1945, the only general conditions of contract for civil engineering works which had been the subject of agreement between a representative body of engineers and the civil engineering contractors was a form published in 1930 by the Association of Consulting Engineers. While this form was in general use by the consulting engineers it had not in fifteen years obtained general acceptance by local and public authorities, who maintained their right to use forms which they themselves had been accustomed to use for many years.

After the war the Federation of Civil Engineering Contractors, finding that the form agreed with the Association of Consulting Engineers was not universally adopted, and also having a desire to improve the conditions under that form so as to eliminate certain risks and liabilities, found that the Institution of Civil Engineers was ready to enter into negotiations for a new form of contract. It was no doubt believed that the Institution was a more authoritative body than the Association and that a form agreed with such a body would be more readily acceptable to local and public authorities. In 1945 agreement was reached with the Institution for the publication of a form of contract which carried with it recommendations of the Institution. This form received support from some, but by no means all, public bodies, as well as from a considerable number of consulting engineers within the Institution, but the Association of Consulting Engineers was not satisfied with the form and refused to recommend it to its members. Without such recommendation it was found that acceptance of the 1945 form was still limited and by no means did it come into universal use. The Institution of Civil Engineers and the Federation of Contractors therefore considered the Association's criticism of the 1945 form, reformed the committee dealing with the matter by including representatives of the Association, and in January of 1950 published a form of contract which in many respects modified the 1945 form and is now recommended by all the constituent bodies for general use. It is published within a red cover and is distinguishable, not only for its colour, but by many changes in the provisions of the earlier form. How far it will be accepted by local and public authorities who have so long preserved the use of their own form has yet to be ascertained, but there can be little doubt that the agreement which has been reached amongst engineers and contractors may now be regarded as the standard form of conditions of engineering contracts. It is true that at no time have the negotiating parties consulted any bodies representing the employing authorities, but the civil engineers have assumed the right to negotiate the contract as representing the persons who will administer the contract on behalf of such bodies.

A stage has now been reached when, if the form of contract is adopted, contractors will be invited to tender, not upon conditions which the employer wishes to impose, but upon conditions which the engineers and the contractors think in all the circumstances are fair conditions to be made between the parties. It may be expected that most employers will accept this as a basis for seeking tenders; others may take the view that they wish to let contracts on their own terms and that if the contractor wishes to carry out their work he must take the risks and liabilities which they impose and for which he has been relieved under the standard form of contract. Any employer may take the view that he is not sufficiently protected under the standard form against claims arising out of unforeseen conditions or against the cost of making good works which prove defective or against damages occasioned by the contractor in carrying out the works; but no doubt, if that is his view, he may find that the number of contractors willing

* Address to Engineering Legal Society, Nov. 17 1950.

to accept the risks which he imposes is limited and in particular that the experienced firms of civil engineering contractors may refuse to tender.

It is our purpose to-night to consider how far the standard condition of contract has relieved the contractor of risks and obligations which he would, under earlier forms of contract, have taken. I think, perhaps, the broadest view of this contract is that it appears to have been negotiated on the basis that both parties to it are to be treated as persons who are desirous of giving the other a square deal. In fact, one criticism might be that it is a gentleman's agreement which does not give to the employing authority sufficient protection against over-greediness of any contractor whom he may employ. In the past it has been a common view that the conditions of contract should so tie up a contractor as to place him at the mercy of the employing authority and his engineer, on the assumption that the engineer will, through his influence and position, see that the contractor is fairly dealt with. The excuse for this attitude in the past has been that the employer may under the present system of tendering and the rule of acceptance of the lowest tender have to employ a contractor upon whom he cannot depend to act reasonably or fairly towards him in the carrying out of his obligations and without limit to the extent of claims which he will think fit to make under the contract. On this aspect of the case it is known that the civil engineers are always desirous of selecting contractors for tendering, not by public advertisement of the work, but by their experience of the firms in question, and I think it may well be said that the standard form has been drawn up on the basis that none but firms known to play the game will be asked to tender. The contract may therefore not be considered by some public authorities as sufficiently protective of the interests of the employer if work is to be let to anybody who may tender the lowest price notwithstanding their inexperience or unreliability.

Looked at as a whole and as a preliminary observation, I think it must be acknowledged that this is a contractor's charter. It certainly relieves him from many of the risks and liabilities which he took under earlier forms of contract, as well as from any tyrannical administration of the contract by the employer or the engineer on his behalf. In a sense, it is a contract which contractors may safely accept at a much lower risk of undertaking work which will prove more expensive than they could anticipate and as such presumably the price tendered will be lower. It is a contract under which the exercise of any discretion by the engineer in so far as it affects payment may be challenged before an arbitrator. It is a contract which enables the contractor to accept the designs and specification of the engineer as not only practicable for construction, but practicable without the necessity of the contractor carrying out any works other than those which are indicated. It imposes upon the employer the obligation to pay for all works and methods of work which could not have been reasonably foreseen.

May we therefore now come to the particular changes in this form of contract from the more usual forms which have been used in the past. There is first a provision for the settlement of disputes, which refers to an arbitrator appointed by the President of the Institution of Civil Engineers any dispute which may arise between the employer or the engineer and the contractor. Although throughout the contract there are references to directions which may be given by the engineer on matters which in his opinion should govern the acts of the parties, or payments by the employer or dates of completion or end of maintenance, the arbitration clause makes it clear that no opinion, direction certificate or valuation of the engineer will preclude the arbitrator from opening up, reviewing and revising and making his decision without regard to any view which might previously have been expressed by the engineer. Indeed, it is important to remember that in reading this contract the powers given to the engineer are all subject to arbitration at the instance of either party, though the actual carrying out of the work until completion must be done under the engineer's direction. This arbitration clause, of course, is of first-rate importance, and I think will generally be accepted as, for many years, the anomaly of the engineer—especially the engineer who is the servant of the employer—having any final power of decision over the sum to be paid by the employer, has been the subject of criticism. At the same time, it must be expected that arbitration or the threat of arbitration is now something to be taken into account in future contracts.

But it is perhaps in regard to the elimination of constructional risks that the contract has made the greatest departure from existing forms of contract. By Clause 12 the contractor, if he goes through the proper formalities which are conditions precedent to a claim, may recover the expense of encountering physical conditions, e.g., running sand, rock, &c., or artificial obstructions, e.g., hidden pipes and cable, which could not have been reasonably foreseen by an experienced contractor. Of course, this is of first-class importance from the employer's as well as the contractor's point of view. Under this form of contract the employer can never be certain that the price given by the contractor for excavating or even for the works to be built in the excavations will be the price which he will eventually be called upon to pay. He and not the contractor may now be said to have taken the risk of these contingencies.

The next risk which has been removed from the contractor is a risk of damage, loss or injury which may happen to the works or to any of the temporary works from what are called the risks. These risks, in addition to unexpected events like war or rebellion, include a cause solely due to the engineer's design of the works, and to the occupation and use by the employer of any portion of the works before completion of the whole. The effect of this clause is that the contractor no longer need concern himself with whether or not the works to be carried out to the engineer's designs are practicable or likely to have any weakness which may cause any damage either to works themselves or to his temporary works. It has often been said that an engineer and his employer take the responsibility for the design and engineers have recognised that it is only right and proper that they should do so, but it must be recognised that if any damage does occur during the carrying out of works the question whether or not the damage is due to one cause or another is a likely cause of dispute. It is, however, doubtful whether there can be any justification for making the contractor responsible for the engineer's design and its practicability, even though it may become extremely difficult to allocate the responsibility for the damage between the design, on the one hand, and the methods by which the contractor carries out his work on the other.

The next important elimination of contractor's risk is in reference to his liability to carry out maintenance work at his own expense. This liability has now been most firmly limited to the repairs and making good of defects which, in the opinion of the engineer (this opinion is subject to arbitration), is due to the use of materials or workmanship "not in accordance with the contract, or to neglect or failure on the part of the contractor to comply with any obligation expressed or implied on the contractor's part under the contract." Therefore the mere existence of a defect does not make the contractor liable for the expense of putting the work in order. This provision is very different from many of the maintenance clauses to which contractors have been liable in the past, when their responsibilities to make good at their own expense arose out of the appearance of the defect in the work, however the defect might have arisen. It is also important to note that before the contractor becomes responsible for any defect he must have received notice in writing from the engineer within the period of maintenance or within fourteen days after its expiration and, that if no notice is given he escapes liability even though the defect is his own fault.

The next matter of importance is that under the contract the engineer is compelled to give a certificate of completion in respect of any substantial part of the work which has both been completed and occupied or used by the employer, even though the work as a whole has not been completed, and that the maintenance obligations in regard to that part will run from the certificate of completion.

I think the matters I have dealt with are the most important distinctions between the standard contract and many of the forms of contract previously used by local and public authorities. But there are a few subsidiary matters which perhaps are worth notice:—

(*a*) If the engineer should order a suspension of the works and the suspension lasts for more than three months then the contractor is entitled to claim that the part so suspended should be treated as an omission (in which case, of course, the contract prices will cease to apply to this work) or if the whole of the work is suspended for more than three months he may claim that the suspension should be treated as abandonment of the contract.

(*b*) There is express provision for extra expenses being paid to the contractor if the employer fails to give him possession of any part of the site at such time as may enable him to proceed with the work in accordance with his programme or with reasonable proposals.

(*c*) The failure of the engineer to give certificates for payment to the full amount to which the contractor becomes liable from time to time carries with it the obligation of the employer to pay interest at the rate of 5 per cent upon all overdue payments.

(*d*) All liability for extraordinary traffic on highways has been excluded with certain safeguards against the contractor's improper use of the roads and provision of protection of roads in the case of special loads.

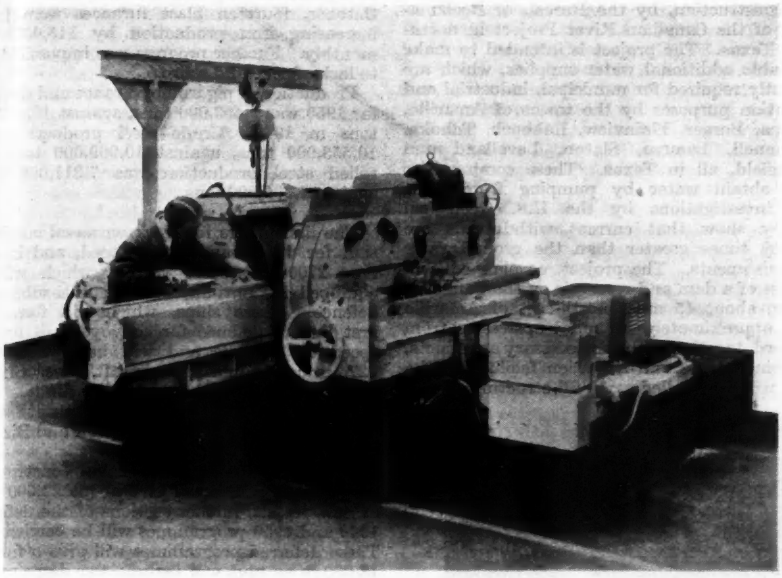
While the above is not, of course, an exhaustive consideration of the changes brought about by this form of contract, the general indications given and examples used will, I trust, be useful to the members of the Society in advising their clients as to its use. The Institution, Association and Federation have recommended the form for general use. It may be that in particular classes of work engineers who may in normal cases use the form may think it necessary to make some modifications of the form, e.g., for dredging. Moreover, it is likely that for works dependent for their completion on the supply of machines or the works of other contractors (e.g., power stations) some modification of the clauses may be necessary to fit the special circumstances of the case.

But, apart from special cases, there can be little doubt that, if this form of contract comes to be generally adopted, the ensuing uniformity of practice must be generally beneficial to all the parties concerned. An employing body may be conservatively attached to its own form, but it should not take very long to become accustomed to the new one. Contractors, on the other hand, if they are tendering on well-known conditions, will be less likely to make mistakes or to miscalculate the risks involved; and the incidence of disputes over the interpretation of the contract should be very much lessened. The uniformity of the conditions of building contracts has, I think, materially reduced the cost of tendering. On the more basic issue of whether the employer should shoulder some of the risks formerly taken by contractors there may be different opinions. All I am able to do is to direct your attention to the changes on the incidence of those risks and to leave the policy to those who are advising the employing authority. In this connection it is significant to note, that in publishing the form, the civil engineering profession, through its most authoritative association, has recommended these changes to employing authorities.

INDUSTRIAL GAS DEVELOPMENT COMMITTEE.—The Industrial Gas Development Committee, which was formerly a committee of the British Gas Council, is to continue its work as a committee of the Gas Council. Mr. H. R. Hems, of the West Midlands Gas Board, and Mr. R. F. Hayman, of the North Thames Gas Board, have been elected Chairman and deputy-chairman, respectively.

A Large Centreless Grinder

A CENTRELESS grinder now being made by Arthur Scrivener, Ltd., Tyburn Road, Birmingham, takes a grinding wheel 24in diameter up to 20in wide and a control wheel



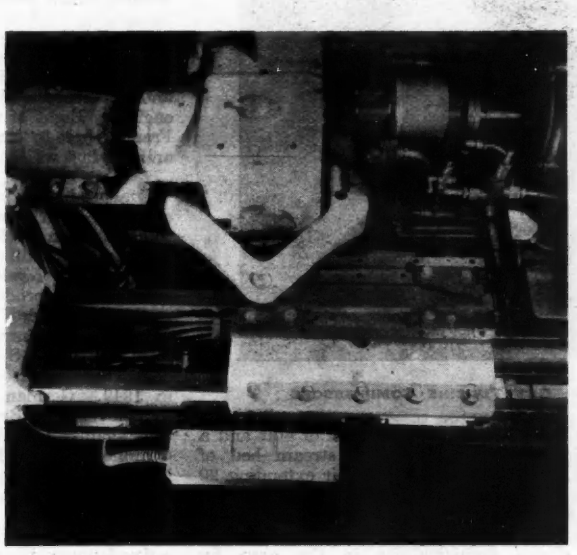
LARGE CENTRELESS GRINDER

18in diameter. The maximum permissible opening between the wheels is 9in. This machine, which works on the controlled cycle principle, is mainly intended for the in-feed method of form grinding. It is driven by a 35 h.p. motor and has a grinding wheel speed of 950 r.p.m. The control wheel has six working speeds from 6·9 to 40·8 r.p.m., and an additional speed of 200 r.p.m. is provided for wheel truing.

The machine has a very heavy control head and a particular feature of its design is the mechanism which has been developed for operating the head in controlled cycle working. This mechanism can be seen in one of the photographs reproduced on this page. Mounted on a bracket projecting from the control head is a combined fixed and roller follower, by which the head is moved. This follower is actuated by cam plates mounted on a slide, which is moved across the follower by the piston of a double-acting hydraulic cylinder. In the first movement of the cam slide, which advances the control wheel to the grinding wheel, the roller follower rides up a steep incline on the cam. After this movement has brought the work into contact with the grinding wheel, progressive movement of the cam slide transfers control from the roller follower to the fixed follower. This follower is actuated by a gradual slope on the cam to feed the control head forwards at a slow speed, the precise distance corresponding to the amount of stock to be removed from the workpiece. At the end of the stock removal movement of the head, the roller follower again takes control of the head and, riding down a steep slope in the cam slide, withdraws the control wheel head quickly from the grinding wheel.

The machine is fitted with a fixed workrest and both heads, which run on ground slideways, are adjusted to the rest. Preliminary coarse adjustments of the heads are mechanically operated through a push-button control, and final close adjustments are then made with a fine feed handwheel. The grinding-wheel head is locked by hydraulic means on the ways.

When it is required to use the machine for straight-through grinding the control wheel and spindle are tilted to any required angle up to 7 deg. from the horizontal by means of a worm and wormwheel. The rate of feed is proportional to the speed of the control wheel and the angle of tilt. During plunge grinding the control wheel is usually tilted to a slight angle of about 20 minutes.



CONTROL HEAD OPERATING MECHANISM

Apart from a starter for the main motor on the left-hand side of the machine, there are three stations from which the various movements of the machine members are controlled. A grinding-wheel control station has push buttons controlling the starting and stopping of the coolant motor and for the adjustment of the grinding head along the main slide. A handle at this station controls the forward and reverse movement of the hydraulically operated truing attachment. A similar station at the opposite side of the machine also incorporates push-button controls for the controlled-cycle mechanism. At the third station one of two valve boxes is provided with a knurled handle, which controls the speed of operation of the controlled-cycle mechanism of the machine. The other valve box carries the same means of adjustment for any type of automatic feeding mechanism that may be applied to the machine for introducing the work between the wheels.

American Engineering News

(From our American Correspondent)

Expansion Programme of the American Steel Industry

The present expansion programme of the American steel industry is believed to be the most ambitious ever undertaken in a short-term period anywhere in the world. If present plans go forward as expected, the steel-producing capacity of the U.S. will have been increased by approximately 14,000,000 ingot tons per annum in the period between January 1, 1950, and December 31, 1952. In comparison, American mills added only about 13,000,000 tons of ingot capacity in the five-year period during the last war. Thus the total ingot capacity of the American steel industry will be in excess of 100,000,000 tons by the end of 1952.

The leader in the present accelerated expansion has been the United States Steel Corporation, the country's largest producer, with a capacity of about 29,000,000 tons. Its plans call for the addition of almost 4,000,000 ingot tons. This figure includes the 1,600,000-ton output of an entirely new steel works, named the Fairless Works, which will be started at Morrisville, Pennsylvania, on the Delaware River, in the spring, and which is scheduled to be ready for operation before the end of 1952. The works will employ 4400 production workers and will produce a wide variety of products, including pipe, sheet, bars, plates and tinplate. With direct siding connections to the Pennsylvania Railroad, the mill will have good transport facilities for the distribution of its output to the Middle Atlantic and New England territories. In addition, the Delaware River is being dredged to facilitate transport of raw materials and finished products. It is expected that the new plant will eventually utilise a part of the high-grade iron ore, which is beginning to be mined in eastern Venezuela.

Awards by Engineering Societies

Mr. Isaac Harter, chairman of the Babcock and Wilcox Tube Company, of Beaver Falls, Pennsylvania, has been awarded the Newcomen Medal "for achievement in the field of steam," at a joint meeting in Philadelphia of the Newcomen Society and the Franklin Institute. The occasion was the second time the medal has been awarded.

The John Fritz Medal for "outstanding scientific contributions to his country and to his fellow-men," has been awarded to Dr. Vannevar Bush, president of the Carnegie Institution of Washington, by the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining and Metallurgical Engineers.

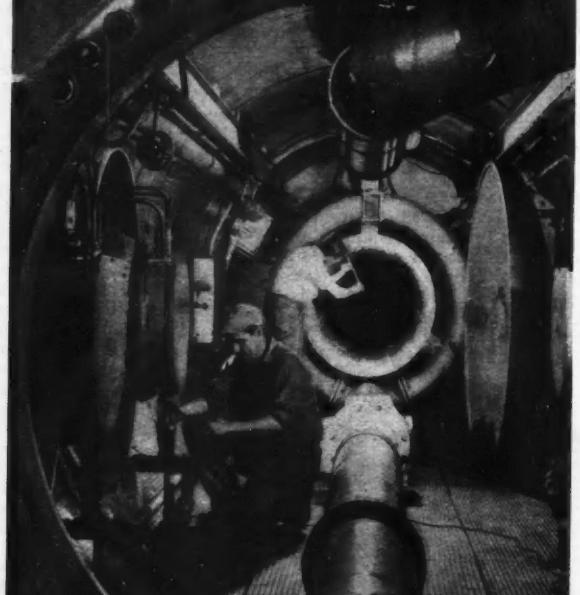
Large Hydraulic Forging Presses

As a result of research conducted by the Air Materials Command of the U.S. Air Force at its pilot plant manufacturing methods at Adrian, Michigan, designs have been developed for the construction of extremely large forging presses, which, eventually, should make it possible to produce entire wing sections of aircraft within one working stroke. The Air Materials Command has now announced

that a contract has been awarded to Hydropress, Inc., of New York, for the construction of two such presses. Details of the two machines have not been divulged, except for a statement that their capacity would be in excess of 45,000 tons. This capacity makes them the largest and heaviest hydraulic presses to be built so far. A 30,000-ton die forging press, which was built in Germany and was taken over by Soviet Russia as war reparations, has up to the present been considered to have been the most powerful machine of its kind. It is hoped that the new die forging and extrusion techniques which these presses will make possible will lead to stronger and lighter sections, thus increasing the payload capacity and the effective range of future aircraft. The presses are expected to be in operation within eighteen months.

General Electric Aircraft Gas Turbine Laboratory

The dedication, in honour of the late Dr. Sanford A. Moss, took place recently of a new aircraft gas turbine laboratory, which has been built by the General Electric Company at Lynn, Massachusetts, to become part of its gas turbine production and test centre. The principal equipment of the laboratory is a 40ft long insulated and pressurised cylindrical steel chamber, which is illustrated herewith. The chamber is intended for the testing and operation under instrumentation of experimental compressors to be developed for gas turbines. It makes possible the simulation of altitudes of up to 70,000ft and of temperatures of as much as 100 deg. Fah. below zero. The chamber is equipped with some 700 instruments, which transmit information to a sound-proof control room, recording the performance of the compressor in operation. In the belief that the compressors offer the greatest opportunity for improvement in the design of gas turbine engines for future aircraft, research on compressors is being emphasised by the company, and the whole of the laboratory is intended to facilitate the testing of the various compressor components. The equipment which has been installed includes a combustion test stand, a small stand for testing scale-model compressors and a blade test stand, which also serves as a source of air for combustion testing. The power required to drive the compressor of such engines as the "J-47," which is in production, is being obtained from a 35,000 h.p. steam turbine power plant, capable of driving compressors supplying air flows of 320 lb per second. Utilising water drawn from the Saugus River nearby and employing four sets of refrigeration compressors and turbines, approximately 14,000,000 cubic feet of air per hour can be cooled to 100 deg. Fah. below zero. When in full operation the laboratory will require 4,000,000 gallons of water per hour. The power plant that drives the compressor through a speed-increasing gear at the rear of the cylindrical test chamber is operated, during tests, from the master control room, where all test readings are taken. The installation makes use of a new instrument, known as a "clearanceometer," which has been developed to measure the actual and instantaneous clearance between the compressor casing and the rotor blade tips at full-speed operation.



TEST CHAMBER FOR GAS TURBINE COMPRESSORS

Presidential Authorisation of Canadian River Project

President Truman has authorised the construction, by the Bureau of Reclamation, of the Canadian River Project in north-west Texas. The project is intended to make available additional water supplies, which are urgently required for municipal, industrial and irrigation purposes by the towns of Amarillo, Pampa, Borger, Plainview, Lubbock, Tahoka, O'Donnell, Lamesa, Slaton, Levelland and Littlefield, all in Texas. These communities now obtain water by pumping from wells and investigations by the U.S. Geological Survey show that current withdrawals are twenty times greater than the ground-water replenishments. The project, as planned, will consist of a dam and reservoir on the Canadian River, about 45 miles north-east of Amarillo and approximately a mile upstream from Sanford, together with the necessary aqueducts, pumping plants and irrigation facilities. The dam will be a rolled earth-fill structure with a crest line of 7200ft, a top width of 40ft and a maximum height above the stream bed of 186ft. It will create a reservoir extending 20 miles upstream, which will have a total capacity of 1,956,000 acre-feet. Water will be pumped from the reservoir and will be delivered to the eleven municipalities in the area by means of about 275 miles of pipe-line. A total of fifteen pumping plants will be required at various points along the pipe-lines. Effluent from the sewage treatment plants of two of the municipalities will be used to irrigate an ultimate total of over 20,000 acres. This kind of irrigation is now being practised successfully in this area and, with proper safeguards, has been approved by health authorities. The total cost of the Canadian River project is estimated at about 85,000,000 dollars.

French Engineering News

(From our French Correspondent)

Temporary figures for steel production for December now enable total 1950 production to be estimated and compared with that for 1949. It would appear that results for these two years are very similar. Between July and October, fourteen blast furnaces were re-lit, increasing iron production by 115,000 tons monthly. Further progress was impossible due to lack of coke and scrap.

Production of pig iron by France and the Saar for 1950 was 9,453,000 tons, against 10,917,000 tons in 1949. Crude steel production was 10,553,000 tons, against 10,909,000 tons and rolled steel production was 7,311,000 tons, against 7,396,000 tons.

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The first orders for work on naval construction for 1951 have been placed, and include four 2700-ton escort vessels, which will be equipped for anti-aircraft and anti-submarine defence. These ships, which will form the first line of defence for convoys, will have a speed of 34 knots and will be armed with 127mm and 57mm anti-aircraft guns. Sixteen 300-ton dredgers will also be built. The programme also includes important work at the bases of Brest, Mers-el-Kebir and Bizerta, the three essential naval ports.

In addition to the 1951 naval construction programme, which will give about 22,600 tons of new vessels, further sections of the deferred 1949 and 1950 programmes will be carried out. These deferred programmes will give a further 18,000 tons and will include two large escort vessels, four small 1500-ton escorts and four submarines.

The new ships will be constructed in naval dockyards and by private builders. The first of them will be completed at the end of 1953 and all will have been launched by the middle of 1954.

The present programme for Mers-el-Kebir will be completed in three years and the new programme, which will include an underground arsenal, will be completed in four years.

Allocations for the merchant navy amount to 15,452 million francs. Of this sum 9000 million are for new construction and will enable 35,000 tons to be built. It is still considered, however, that orders placed by the government are insufficient to ensure full work to French yards, whose capacity has reached 300,000 tons a year.

* * *

The "S.E.-2010 Armagnac," the first of a group of fifteen similar aircraft, has just made its first flight. It is equipped with four Pratt and Whitney "Wasp Major," 3500 h.p. engines. Eight of the machines will go to Air France, three to the Cie T.A.I., three for export, and the last will be adapted for jet propulsion.

* * *

Coal production in France in 1950 is estimated at about 1 per cent below that of 1949. The total is given as 52,515,000 tons. The 1950 target was 55 millions, but under-consumption in the spring resulted in dismissals of miners and a fall in production. A great effort was made at the end of the year, however.

French coal imports fell sharply. Imports from the United States practically ceased with 48,053 tons imported, compared with 4½ millions in 1949. German imports fell from 7 to 5 million tons and British imports were 1,247,725 tons against 1,654,937 tons in 1949, and over 6 million tons in 1938. Rearmament is now increasing consumption, however, and imports in 1951 are expected to increase.

* * *

The Algerian National Assembly has accepted a development plan for the industrialisation of the country. The plan calls for the establishment of a steel industry, able to produce 72,000 tons of finished products per year. The activities of the mechanical industries will also be stepped up, with the aim of manufacturing products instead of importing them. It is planned to make agricultural machinery and automobile parts in new factories, and also to establish electric bulb manufacturing plant, cement plant and an important chemical industry.

Industrial and Labour Notes

Manpower and the Armament Programme

The quarterly meeting of the National Joint Advisory Council—which consists of representatives of the British Employers' Confederation, the Trades Union Congress and the nationalised industries—was held in London on Wednesday of last week, under the chairmanship of the Minister of Labour, Mr. Aneurin Bevan. An official statement, issued by the Ministry of Labour after the meeting, showed that much of the Council's discussion was concerned with the various manpower aspects of the armament programme.

It was recognised that a large part of the additional manpower to be employed on work for the defence programme might be obtained by the switch from civilian to defence production of the labour forces existing in certain factories. But the Council also realised that the actual numbers to be employed in some undertakings would have to be raised, and although the increase might come in part from manpower rendered redundant in other employments, through the scarcity of certain raw materials, there would still be need for substantial numbers of workers and for the most efficient use of existing labour to meet the competing demands of defence, exports and home consumption.

After considering what action might be recommended to employers and trade unions, with a view to achieving the necessary production, the Council agreed that the attention of its constituent members should be drawn to the desirability of advance notification of redundancy and of advance registration of workers likely to become redundant. That step, it was thought, would reduce to a minimum any periods of unemployment between jobs and enable employment exchanges to place the workers concerned in employment which would make full use of their skill. In order to overcome the shortage of skilled workers, it was agreed that schemes of training, upgrading and dilution should be developed by different industries, supplemented in suitable cases by training on the lines followed during the war in Government training centres. Other recommendations made by the Council were that women should be employed to a greater extent on appropriate semi-skilled processes, and that training should be provided for them both within industry itself and in Government training centres; that each industry should be asked to consider through its appropriate machinery, whether the extension of hours of work by the introduction of systematic overtime where suitable would be of assistance; that the importance of avoiding unfair competition in the recruitment of labour should be emphasised on both sides of industry; and that industries should be asked to consider what measures were desirable in order to secure the most efficient use of present labour forces.

Engineering Wages Dispute

During the past two or three weeks engineering and shipbuilding workers at some establishments in the north have been imposing a ban on piecework and overtime, as a protest against the wage award negotiated last November between the Confederation of Shipbuilding and Engineering Unions, the Engineering and Allied Employers' National Federation, and the Shipbuilding Employers' Federation. The award, it may be recalled, provided for increases of eleven shillings a week for skilled workers and eight shillings a week for unskilled workers, and it also provided that those grades of workers whose bonus payments brought their earnings above the minimum rates would receive diminishing increases. The adjustment of piecework prices or times, it has been stated, would enable an average worker to earn at least 45 per cent on the existing time rates instead of 27½ per cent, as hitherto. But the complaint of those who have imposed the ban on piecework and overtime seems to be that the level of their weekly earnings should be increased by eleven shillings or eight shillings. A meeting between the Engineering and Allied Employers' National Federation and the Confederation of Shipbuilding and Engineering Unions, to discuss the dispute, was held in London on Monday last. Subsequently, it was stated that the unions concerned would instruct their members who had imposed the ban to resume normal working immediately so that negotiations over local grievances might begin.

Dock Workers' Wages

On Thursday of last week, a national delegate conference of dock workers accepted a wage increase of two shillings a day, which brings the minimum for a day's work to 21s. and provides for an increase of eleven shillings, to £5 15s. 6d., in the time rate for a full week's work of eleven shifts. The offer also includes proportionate increases for pieceworkers, who comprise over 90 per cent of this country's dock labour.

On Friday last, however, an unofficial strike of dockers began at Birkenhead and Liverpool as a protest against the award which the union delegate conference had accepted. By Tuesday of this week the National Dock Labour Board reported that about 11,000 dock workers on Merseyside were taking part in the strike, their unofficial leaders demanding an increase of six shillings a day instead of the two shillings, which was accepted after negotiation in the constitutional manner. Work was proceeding normally at other ports.

When he was questioned in Parliament on Monday about this unofficial dock strike, the Minister of Labour, Mr. Bevan, said that the Government would not intervene while the efforts of the Transport and General Workers Union officials were succeeding.

An O.E.E.C. Cost Accounting Mission

The Organisation for European Economic Co-operation has announced that a team of thirty-five experts in cost accounting methods, drawn from its member countries, has arrived in New York. This mission will spend two months in the U.S.A. studying works accounting and cost control practices employed in representative industrial enterprises. Members of the mission will visit industrial undertakings of all types and sizes, and on their return will draw up a report which, it is hoped, will assist European industrial undertakings to eliminate wasteful and out-of-date methods of cost accounting.

Non-Ferrous Scrap

The Minister of Supply has made the Non-Ferrous Metals Prices Order (S.I. 1951, No. 155), which fixes maximum prices for non-ferrous scrap. The intention is to discourage hoarding and stabilise scrap prices so that they are in reasonable relation to the prices of virgin metal. The Order came into operation on February 3rd.

The Ministry of Supply has stated that prices of non-ferrous metal scrap in recent weeks have been reaching inflated levels and in many cases scrap has been offered at prices exceeding those of virgin metal. At the same time there has been some falling off of supplies owing, it is believed, to scrap being held back against a further rise in price. The Ministry added, of course, that any prolonged interruption in the flow of non-ferrous scrap for reuse would have a serious effect on production. Under the terms of the Order, invoices of scrap transactions must describe the material sold and show how the price is calculated.

In the near future, the Minister expects to make a further Order, to provide for licensing the acquisition of non-ferrous scrap and secondary metal and for the rendering of periodical stock returns. He has stated, however, that he is anxious to avoid instituting a detailed distribution scheme. The immediate return of all scrap for re-use is the best way to prevent that step and the Ministry of Supply is therefore appealing to all concerned to co-operate in ensuring that the maximum flow of non-ferrous scrap is achieved.

New Company Registrations

The table of new company registrations, which is compiled annually by Jordan and Sons, Ltd., 116, Chancery Lane, London, W.C.2, shows that during 1950 there were 13,278 new companies in England and Wales placed on the Register in London. This, it is stated, was a reduction of 3 per cent from the 1949 total of 13,755 companies. The aggregate nominal capital of the companies registered last year was £67,762,072, compared with £76,496,452 in 1949. The table reveals that, whilst only twenty-six public companies were registered in 1950, the creation of new private companies continued above pre-war levels. There were 13,095 private companies incorporated last year, with a nominal capital of £66,535,347.

A classification of the trades and industries represented in last year's company registrations shows that 1275 companies, with a nominal capital of £7,724,957, were concerned with engineering. In 1949 there were 1256 new engineering companies registered. It is pointed out that the pattern of registration is persistent, and that the prime necessities—food, shelter and clothing—continued to attract the greatest activity throughout 1950, although it is suggested that the rearmament programme may possibly upset that balance this year.

Joint Consultation

The Institute of Personnel Management has just published a pamphlet entitled "Joint Consultation—a Practical Approach." The Institute realises, of course, that there is now a considerable amount of literature on the subject, but it feels, nevertheless, that there is a need for a practical approach to joint consultation in industry, and this pamphlet has been designed to meet that need.

The pamphlet opens with a brief historical review of joint consultative committees, and goes on to discuss the necessity for joint consultation and to put forward suggestions about the constitution and running of consultative committees. The right approach to joint consultation, it is claimed in the pamphlet, is one in which the management has a positive desire to consult with its employees collectively, and to spread information amongst them in the belief that they are capable of making a contribution to the efficiency of the undertaking. The employees, the pamphlet says, will be eager to help in so far as they are convinced that they have a common interest with the management in the success of the organisation.

The pamphlet was prepared by a study group, over which Mr. H. C. Rutherford, a director of Venesta Ltd., presided. Copies, price 2s. 6d., are obtainable from the Institute of Personnel Management, Management House, Hill Street, London, W.1.

Coal Production

Coal output last week was about 11,000 tons greater than in the preceding week. Production from the deep mines amounted to 4,221,500 tons and from opencast workings 201,200 tons, giving a total of 4,422,700 tons. In the first five weeks of this year, production, deep-mine and opencast, totalled 21,266,400 tons, compared with 21,287,100 tons in the corresponding period of last year. The latest report from the Ministry of Fuel and Power shows that the steady increase in mining manpower continues, the number of workers on colliery books at the end of January being 694,800, of whom 286,300 were working at the face. But in the week ended January 27th coal consumption, inland and export, was 4,614,000 tons and distributed stocks had declined to 10,455,000 tons.

Notes and Memoranda

Rail and Road

BOOKS ON TRANSPORT.—The County Libraries Section of the Library Association has compiled a useful reader's guide to books and publications on rail, road, water and air transport. Its principal aim is to recommend books in these fields suitable for the general reader. The lists of books contained in the guide do not, of course, include all the literature now available, but they certainly mention a comprehensive selection, covering transport history, management and control, economics and operation.

A NEW RAILWAY WHEEL-MAKING PLANT.—At the Trafford Park Works of Taylor Bros. and Co., Ltd., the manufacture of railway wheels is being transferred to a new plant constructed as part of the steel industry's development plan, at a cost in excess of £750,000. This plant, said to be the most modern of its kind in the world, has been designed to manufacture forged and rolled steel solid wheels and disc centres at a continuous rate of sixty per hour and will be in production within the next few weeks. With the new equipment it will be possible to produce a wheel within close tolerances so that subsequent machining may be reduced to a minimum. In laying down the new plant, particular attention has been paid to improved methods of handling, to ensure rapid transfer of material between the various items of plant. All the equipment is operated from two control rooms.

TRANSPORT OF A HEAVY LOCOMOTIVE ACROSS LONDON.—A prominent exhibit at the Festival of Britain will be a 2–8–2 "WG" class locomotive, built for the Indian railways by the North British Locomotive Company, Ltd., of Glasgow. The gauge of this locomotive made it impossible for it to be brought to the Festival site in London by the normal railway route and it was loaded on to a vessel at Greenock and carried to the Surrey Commercial Docks by sea. The delivery of the locomotive and its tender from the Surrey Docks to the Festival site was undertaken by the road transport firm, Robert Wynn and Sons, Ltd., of Newport, Mon. The magnitude of the task involved in transporting the load across London will be appreciated when it is pointed out that the locomotive and tender weigh some 170 tons and they have a combined length of just over 78ft. The maximum height of the locomotive is 13ft 10½in and the width 10ft 6in. Two sixteen-wheeled trucks were used for the transport of the locomotive and the tender. These trucks are hauled by their own tractors and for specially heavy haulage work a second tractor is attached to the rear end, the drivers of the two tractors being in constant telephonic communication with each other whilst travelling. The locomotive was carried on a truck 130ft long and 13ft wide, hauled by a 250 h.p. tractor and pushed by a 100 h.p. tractor. In this particular job the combined weight of the locomotive and truck was some 130 tons. A 90ft long truck, which was used for carrying the tender, has a 100 h.p. tractor and weighed about 65 tons when loaded.

Air and Water

TRAINING R.A.F. NAVIGATORS.—Air Service Training, which is a member company of the Hawker Siddeley group, states that it is now giving basic training to Royal Air Force navigators at its school at Hamble. The first training course began on February 7th. During the second World War, the company was responsible for the training of more than 40,000 R.A.F. and Allied Air Force personnel in flying, airfield control and aircraft engineering.

B.O.A.C. "MONARCH" SERVICE.—The British Overseas Airways Corporation is to introduce a new air service between New York and London on March 1st. The service will be known as the "Monarch" and will be operated by pressurised, double-decked "Stratocruiser" air liners, flying non-stop between New York and London in eleven and a half hours. At first there will be three flights a week in each direction, increasing to five a week on April 1st and to a daily service from May 1st.

SHIPYARD BROCHURE.—Chantier et Ateliers de Saint-Nazaire (Penhoët), which celebrated its golden jubilee last year, has recently published an illustrated brochure on its shipyards. The book is divided into sections and the early chapters trace the development of the company, the years 1861–1900 covering the history of the parent organisation, Chantier de Penhoët. The period 1900 to 1920 is next described, followed by a review of the work completed during the next two decades, which included the Atlantic liner "Normandie." The work of rehabilitation of the yards after their almost total destruction during the war is then reviewed. In the second part of the book particulars of the yards at Penhoët and Normandy and of the ships built during the post-war years are given. Production methods and technical advances are discussed and special chapters deal with the questions of personnel, training schools and welfare. Throughout the brochure an excellent series of photographs illustrate every aspect of the shipbuilding activities of the firm.

THE LATE MR. C. W. CAIRNS.—We regret to record the recent death of Mr. Charles Waldie Cairns, M.Sc., who was, until his retirement in 1949, owing to ill-health, Superintendent Engineer of Cairns, Noble and Co. Mr. Cairns gained his engineering experience with R. and W. Hawthorn, Leslie and Co., Ltd., Vickers, Ltd., and the Central Marine Engine Works, before joining Cairns, Noble and Co., in 1903. He was a member of the Institution of Naval Architects, a Fellow of the North East Coast Institution of Engineers and Shipbuilders and a pioneer in the use of geared turbines in merchant ships.

Miscellanea

THE LATE MR. J. DANEK.—We have learned with regret of the death, on January 24th, of Mr. J. Danek, managing director of Specto, Ltd., Vale Road, Windsor.

FILMS IN TRAINING FOR INDUSTRY.—The Scientific Film Association is arranging a conference on "The Use of the Film in Training for Industry," which will be held at the Hotel Majestic, St. Anne's on the Sea, during the week end March 30th to April 1st. The discussions will deal with films used for training in the textile, engineering and building industries, and during the conference a number of films will be screened. They will include professionally made films and also some amateur-made examples. Full particulars of the conference can be obtained from the Scientific Film Association, 4, Great Russell Street, London, W.C.1.

WEST BENGAL COAL SURVEY.—Investigations made by Indian geologists have shown that adequate supplies of low-grade coal suitable for the manufacture of synthetic oil are available in the country. *Indian Trade and Industry* says that from a survey carried out in four coal-bearing areas in West Bengal and Bihar it has been estimated that nearly 600 million tons of quarry coal with an ash content varying between 12 and 35 per cent could be obtained. The geologists have recommended the establishment of a synthetic oil plant in the East Raniganj area in West Bengal. In the other three areas similar plants may be constructed at various coalfields after further investigations.

BOILER BROCHURE.—We have received from Cochran and Co. Annan Ltd. its new publication entitled "Cochran Boilers Illustrated." The brochure is non-technical and presents a representative pictorial record of coal, oil, gas and pulverised fuel-fired Cochran boiler installations and steam storage accumulators, the only particulars given being size, pressure and output. There is an aerial photograph of the company's Newbie works at Annan, followed by views of various sizes of vertical boilers at work in hospitals, laundries, and on board ship. Many examples of "Sinuflo" economic boilers are included and also the waste heat pattern as supplied to steel works. Ruths (Cochran) steam accumulators of large capacity are featured. Tables at the end of the booklet give more detailed information of the different classes of boilers and reference is made to other publications relating to the company's products.

INSTITUTE OF METALS AWARDS.—The Council of the Institute of Metals has made the following awards of medals for 1951:—Institute Platinum Medal, to Dr. Randolphe William Diamond, vice-president and general manager of the Consolidated Mining and Smelting Company of Canada, Ltd., in recognition of his outstanding services to the non-ferrous metal industries in connection with researches on differential flotation as applied to the complex Sullivan ore, and as manager of the largest combined copper and lead producer in the world; the W. H. A. Robertson Medal, to Mr. Christopher Smith, chief metallurgist, James Booth and Co., Ltd., for his paper on "The Extrusion of Aluminium Alloys"; the Walter Rosenhain Medal, to Professor Geoffrey Vincent Raynor, D.Sc., Professor of Metal Physics at the University of Birmingham, for his outstanding contributions in the field of physical metallurgy, in connection with our knowledge of the constitution and formation of alloys.

Personal and Business

MR. T. H. R. PERKINS has been appointed a director of F. Perkins, Ltd., Peterborough.

MR. J. M. BROMLEY has joined the sales staff of Rockwell Machine Tool Company, Ltd., at the Midland office at 132, Steelhouse Lane, Birmingham.

POWELL DUFFRYN, Ltd., announces that Sir Henry Wilson Smith, Mr. Alfred Read, Mr. M. B. Reid, and Mr. T. S. Overy have been appointed additional directors.

THE RAILWAY EXECUTIVE announces that Mr. E. D. Trask, M.I.Mech.E., M.I.Loco.E., assistant motive power superintendent, Scottish Region, has been appointed motive power superintendent, Scottish Region.

THE DE HAVILLAND AIRCRAFT COMPANY, Ltd., announces the appointment to the board of directors of Mr. H. Povey, general production manager; Mr. C. S. Thom, business manager; and Mr. A. F. Burke, managing director of the de Havilland Engine Company, Ltd.

J. H. FENNER AND CO., Ltd., states that Mr. A. H. Bingley has been appointed factory representative in South Africa as from March 1st. He will advise on mechanical power transmission from the office of the firm's agents, Reunert and Lenz, Ltd., P.O. Box 92, 86, Main Street, Johannesburg.

THE BRITISH AND IRISH STEAM PACKET COMPANY, Ltd., announces that Captain A. R. S. Nutting has been appointed chairman, in succession to Sir Alfred H. Read, who has retired. Other changes in the board include the retirement of Mr. A. A. Lough and the election of Sir James Milne, K.C.V.O.

MR. E. D. E. ANDREWES, Mr. T. J. Boulstridge and Mr. P. Grove have been elected to the board of Tube Investments, Ltd. Mr. I. Turner has been appointed secretary of the company in succession to Mr. A. B. I. Dick, who has resigned in order to give full time as managing director of the subsidiary, Talbot Stead Tube Company, Ltd.

MR. F. J. BATES, works director of B.S.A. Tools, Ltd., and Index Automatic Machine Company, Ltd., and a director of Cardiff Foundry and Engineering Company (1947), Ltd., and Leo C. Steinle, Ltd., has retired from active participation in the work of the board, after being with the B.S.A. Tools group for forty-two years. His services will remain available in a consultative capacity.

MR. A. L. FIELDING, M.I.C.E., M.I.E.E., A.M.I. Mech.E., advisory and inspecting engineer for the New South Wales Government, has relinquished his appointment as official representative in London for the Snowy Mountains Hydro-Electric Authority of the Australian Commonwealth Government, owing to pressure of work for the State Government. He will continue to act as consultant to the Authority, whose business is now being conducted from 1, Regent Street, London, S.W.1. Correspondence should be addressed to the engineer-in-charge at that address.

Launches and Trial Trips

IXION, passenger and cargo liner; built by Harland and Wolff, Ltd. for Alfred Holt and Co.; length between perpendiculars 485ft, breadth moulded 69ft, depth moulded 38ft 6in, 10,125 tons gross, twenty-nine passengers; single set of triple-expansion double-reduction geared turbines, taking high-pressure superheated steam from two Foster-Wheeler boilers; 14,000 s.h.p.; three 350kW diesel generators, one 550kW turbo-generator. Trial, January 5th.

CRNA GORA, cargo and passenger liner; built by the Netherlands Dock and Shipbuilding Company, for the Jugoslavenska Linijska Plovedba; length b.p. 435ft, breadth moulded 59ft, depth moulded 39ft 5½in, deadweight 9000 tons; N.D.S.M.-Stork double-acting diesel engine, six cylinders, 6250 b.h.p., 16 knots. Launch, January 20th.

MAJORIAN, motor tanker; built by Vickers-Armstrongs, Ltd., for Aksjerederiet Juilian, Norway; length b.p. 565ft, breadth moulded 80ft, depth moulded 42ft 6in, deadweight 24,500 tons; Vickers-Doxford oil engine, six cylinders, 7200 b.h.p. Launch, January 22nd.

EGYPTIAN PRINCE, cargo-passenger liner; built by the Burntisland Shipbuilding Company, Ltd., for the Prince Line, Ltd.; length b.p. 349ft, breadth moulded 51ft 3in, depth moulded 30ft 9in, deadweight 4625 tons; Hawthorn-Doxford oil engine, four cylinders, 600mm diameter by 2320mm combined stroke, 3300 b.h.p., heavy fuel. Trial, January.

British Patent Specifications

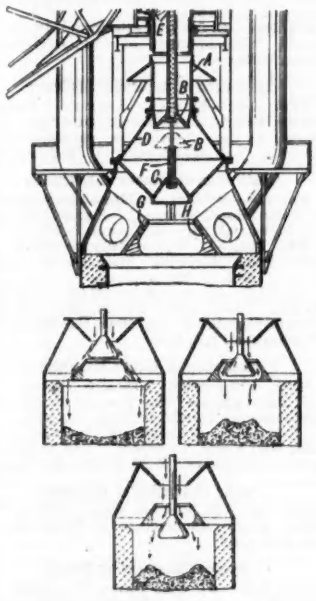
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

METALLURGY

648,572. October 28, 1948.—IMPROVEMENTS IN BLAST-FURNACE CHARGING GEAR, The British Iron and Steel Research Association, of 11, Park Lane, London, W.1; and Ernest Leontine Diamond, of the association's address.

In the drawing the charges of material are deposited in a revolving hopper *A* situated above a pair of vertically movable bells *B* and *C*, which can be independently operated to admit the material into the furnace. The upper and smaller bell controls the admission of material into the chamber *D* and is fixed to the lower end of a vertical rod *E*, which extends into a joint above which the operating mechanism is arranged. The lower and larger bell *C*, with the operation of which the invention is principally concerned, controls the admission of charge material into the furnace from the chamber



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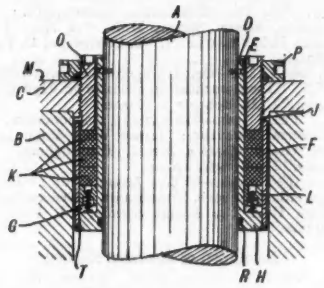
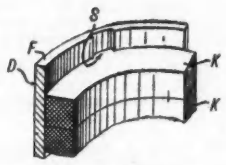
D and is fixed on the lower end of a rod *F* extending within the small bell rod *E*, which is connected to the steam or hydraulic operating mechanism. At the top of the furnace and situated directly below the large bell *C* is a fixed hollow truncated cone or deflecting member *G* with which the lower bell co-operates to vary the distribution of the material deposited in the furnace. The diameter of the upper edge of the deflecting member *G* is slightly greater than the lower edge of the large bell *C*, which can be dropped to bring its lower edge above, within, or below the deflecting member. The inner surface of the deflecting member is formed with an inwardly and downwardly sloping projection or annular flange *H* to impart additional deflection of the charge materials. The three drawings show the delivery of material effected by the three positions of the lower bell.—*January* 10, 1951.

MISCELLANEOUS

644,017. May 7, 1947.—IMPROVEMENTS IN AND RELATING TO HYDRAULIC PACKINGS FOR ROTATING SHAFTS, James Walker and Co., Ltd., (*Inventors: Thomas Frank Watson and William Thomas Tank*), of "Lion" Works, Woking, Surrey.

In the accompanying drawings the upper view is a section through a gland wherein soft members are used as the sealing medium, and the lower view shows a modification to accommodate a sealing medium incorporating one or more carbon rings or other members of a hard substance. Referring to the upper drawings, the rotating shaft *A* of a pump is mounted within the bore of a gland or stuffing box *B*, the cover *C* of which is secured in the usual manner. The sealing medium is contained within a housing *D*, which consists of an inner sleeve *E* and an outer surrounding sleeve *F* of larger diameter, with an annular space *G* between. The housing so formed is secured to the shaft so as to rotate with it and is constructed so that the securing means can be located outside the length of the stuffing box or gland body. The outer end of the inner sleeve *E* projects beyond the outer face of the gland cover. The housing is secured to the





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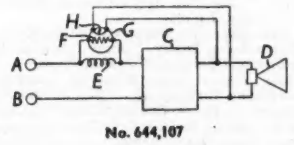
shaft by grub screws, which can be extracted and the housing withdrawn without dismantling the body of the gland or stuffing box. The annular space *G* has a closed end *H* and an open end *J*. In the construction shown the sealing medium is formed from three rings *K* of a soft material, pressed into the annular space against a spring-loaded header ring *L*. The gland cover *C* is made in two portions, a flange portion *M* in the form of a flat ring which is bolted to the body of the stuffing box or gland, the bore of the ring being threaded to take an externally threaded ring *O*, the inner face of which is ground to form the sealing surface of the gland cover, and which may be adjusted to vary the pressure on the sealing members. The ring is locked in the adjusted position by a ring *P*. Leakage along the length of the shaft can be eliminated or reduced to a minimum by the provision of one or more sealing members *R* in a groove provided in the bore of the housing. When sealing members of carbon or other hard substance are used, they are keyed to prevent rotation on the shaft, and this is effected as shown in the lower view, by providing the outer peripheral edge of each ring with one or more radially extending lugs *S*, each of which engage in a groove machined in the outer sleeve. By drilling one or more radial holes *T* through the wall of the outer sleeve pressure fluid is permitted to enter the annular space *G* behind the sealing members to assist in increasing the pressure between the contacting sealing faces.—*October* 4, 1950.

ELECTRICAL ENGINEERING

644,107. February 11, 1948.—IMPROVEMENTS IN OR RELATING TO ELECTRIC SIGNAL TRANSMISSION CIRCUITS WITH AUTOMATIC LEVEL CONTROL, Standard Telephones and Cables' Ltd., of Connaught House, 63, Aldwych, London, W.C.2, England (*Inventor, William Thomas Gibson*).

When transmission circuits or amplifiers are used for conveying speech or music for reproduction by a loud speaker, it is often required to provide means for muting the circuit so that the



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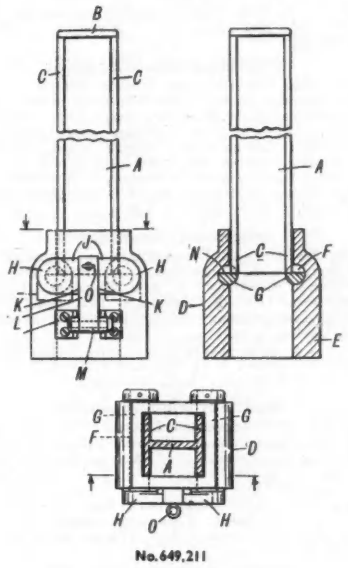
background noise is reduced during silent periods. The present invention proposes a simple arrangement for muting the circuit. It provides an electric transmission circuit associated with a network including a thermistor for controlling the frequency characteristic of the circuit. The network is adapted, in the absence of signals, to cause the circuit to transmit the upper frequencies of the signal frequency band at a relatively lower level than the lower frequencies. Means are provided for applying the signals, when present, to control the resistance of the thermistor, in such manner as substantially to equalise the transmission levels of the said upper and lower frequencies. Referring to the accompanying diagram, speech or music signals from a gramophone pick-up, or broadcast receiver, or any other source, are applied at terminals *A* and *B*, which are connected to the input circuit of a suitable voice frequency amplifier *C*. The output of the amplifier is connected to the usual loudspeaker *D* or other device. Connected in series with terminal *A* is an inductance *E* shunted by the resistance element *F* of an indirectly heated thermistor *G*. The heating coil *H* of the thermistor is connected across the output of the amplifier. A thermistor suitable for the circuit of the present invention is described in Patent Specification No. 557,559.—*October* 4, 1950.

MINING ENGINEERING

649,211. September 6, 1948.—IMPROVEMENTS IN OR RELATING TO PIT PROPS, Albert Parry Jones, 7, Westfield View, Canklow Road, Rotherham, and William Herbert Fearnley, 14, Kent Avenue, Rawmarsh, near Rotherham.

This invention provides improvements in the construction and operation of collapsible pit props.

In the drawing, a prop *A* of H-section, suitably formed at its upper end to receive an applied load—for example, by the addition of a welded plate *B*—is carried by a pedestal *D*. The upper end of the pedestal surrounds the foot of the prop with a slight amount of play. The lower walls of the pedestal are thickened as at *E* to provide a wider base for the firm support of the pedestal. The thickened walls also provide for two holes *F*, each



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hole breaking into the aperture by rather less than half its diameter. From one side of the pedestal supporting pins *G* are inserted, making a close fit with the holes, which form at each end bearings in which the pins are rotatable. At the side of the pedestal from which they are inserted, the pins have enlarged heads *H* provided with extensions *J*, each with a flat face *K*, which faces when brought opposite each other by rotation of the pins are separated by the width of an abutment block *L* having a hinge pin *M* carried by brackets on the side of the pedestal. The other ends of the pins have collars with holes for split pins to retain them, and yet permit them to rotate freely in the holes. The length of each pin extending across the aperture is cut away to form a flat surface *N*, which, with the extensions *K* in the position shown in the drawing, causes each surface *N* to project as a ledge into the aperture. The two ledges thus provide a support for each flange of the prop, and the tendency of the pins to rotate under the load applied through the prop is completely resisted by the interposition of the abutment block *L* between the faces on the heads of the pins. The close fit of the intermediate lengths of the holes *F* with the pins *G* enable some of the load to be taken over these lengths, instead of wholly by the journals of the pins. The abutment block *L* is provided with means such as an eye *O* by which a sufficient pull can be applied to allow the block to be completely withdrawn from between the heads, when the load applied through the prop on the overhanging ledges causes the pins to rotate in the holes. This brings the faces flush with the inner faces of the aperture and allows the foot of the prop to pass freely down the aperture, the height of the ledges above the base of the pedestal being sufficient to free the prop from the load that it has been carrying. An alternative construction with a sliding head is also shown in the specification.—*January* 24, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

Mon., Feb. 12th.—N.W. LONDON BRANCH: "Prince of Wales," Kingsbury Road, N.W.9, Lecturettes by Branch Members, 7.15 p.m.

Tues., Feb. 13th.—S.W. LONDON BRANCH: St. George's Hall, St. George's Road, Wimbledon, "A Random Lighting Review," E. A. Langsdon, 8.15 p.m.

Wed., Feb. 14th.—BRADFORD BRANCH: Midland Hotel, Bradford, "The Aims and Objects of the A.S.E.E.," L. L. Emmett, 7.30 p.m.——KENT BRANCH: Royal Star Hotel, Maidstone, Film Lecture, "Seascan Radar," 8 p.m.

Sat., Feb. 17th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Electronics," J. E. Fielden, 7.30 p.m.

British Institution of Radio Engineers

Wed., Feb. 14th.—S. MIDLANDS SECTION: E. Midlands Electricity Board, Coventry, "A Survey of Television Development and its Problems," H. J. Barton-Chapple, 7.15 p.m.——N.E. SECTION: Neville Hall, Westgate Road, Newcastle-upon-Tyne, "The Use of Foster's Theorem in Circuit Design," E. Williams, 6 p.m.

Diesel Engine Users Association

Thurs., Feb. 15th.—Caxton Hall, Westminster, S.W.1, Informal Discussion on "Operating Problems," 2.30 p.m.

Illuminating Engineering Society

Tues., Feb. 13th.—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "The Extension of the Gas Arc Condition," H. W. Cumming, 6 p.m.

Thurs., Feb. 15th.—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, Eastgate Street, Gloucester, "Sodium Lamps and their Application," A. W. Gostt, 6.30 p.m.——NOTTINGHAM CENTRE: Gas Showrooms, Parliament Street, Nottingham, "Street Lighting," W. R. Stevens, 5.30 p.m.

Incorporated Plant Engineers

Tues., Feb. 13th.—E. LANCS BRANCH: Engineers' Club, Albert Square, Manchester, "Generation and Distribution of Electricity," R. A. S. Thwaites, 7.15 p.m.

Wed., Feb. 14th.—E. MIDLANDS BRANCH: Welbeck Hotel, Nottingham, "Geology in the Service of Man," W. Davies, 7 p.m.

Thurs., Feb. 15th.—LIVERPOOL AND N. WALES BRANCH: Radiant House, Bold Street, Liverpool, "Drawings for Plant Engineers," L. E. Stapleford, 7 p.m.

Institute of British Foundrymen

Sat., Feb. 10th.—SCOTTISH BRANCH: Royal Technical College, George Street, Glasgow, "Experiences While Visiting Foundries in the U.S.A. as Members of Productivity Teams," reports by E. J. Ross and J. Jackson, 3 p.m.

Wed., Feb. 14th.—BIRMINGHAM AND W. MIDLANDS STUDENTS' SECTION: Visit to the Laboratories of the Mond Nickel Company, Ltd., Wiggin Street, Birmingham, 16, 2.30 p.m.

Institute of Industrial Supervisors

Tues., Feb. 13th.—DUDLEY AND DISTRICT SECTION: Technical College, Dudley, "The Money in a Factory," W. H. Davies, 7.30 p.m.——KIDDERMINSTER SECTION: Carpet Trades, Ltd., Mill Street, Kidderminster, "The Foreman and the Personnel Department," J. Maslin, 7.30 p.m.

Thurs., Feb. 15th.—BRISTOL SECTION: Central Hall, Oldmarket, "Motion Study," N. G. Reece, 7.30 p.m.——COVENTRY SECTION: Geisha Cafe, Hertford Street, Coventry, "The Foreman and the Personnel Department," C. Gibbons, 7.30 p.m.

Institute of Marine Engineers

Tues., Feb. 13th.—85–88, The Minories, London, E.C.3, "Corrosion-Resistant Materials," L. W. Johnson and E. J. Bradbury, 5.30 p.m.——College of Technology, Liverpool, "Construction of Marine Boilers," A. P. Monk, 7 p.m.

Thurs., Feb. 15th.—College of Technology, Belfast, "Construction of Marine Boilers," A. P. Monk, 7.30 p.m.

Institute of Navigation

Fri., Feb. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The American Plan for Air Traffic Control," D. O. Fraser, 5 p.m.

Institute of Petroleum

Wed., Feb. 14th.—Manson House, 26, Portland Place, London, W.1, "Petroleum Waxes," T. C. G. Thorpe, 5.30 p.m.

Institute of Road Transport Engineers

Tues., Feb. 13th.—E. MIDLANDS CENTRE: Mechanics' Institute, Nottingham, "Vacuum and Air Brakes," 7.30 p.m.——WESTERN GROUP: Grand Hotel, Bristol, "The Manufacture and Performance of Brake Linings," J. G. Remington, 7.30 p.m.

Wed., Feb. 14th.—N.W. CENTRE: Engineers' Club, Albert Square, Manchester, "Trends in Vehicle Design: With particular reference to the Commercial Show, 1950," P. M. A. Thomas, 7 p.m.

Thurs., Feb. 15th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, W.C.2, "Tyre Inspection Panels," W. H. Binns, 6.30 p.m.——N.E. CENTRE: Hotel Metropole, Leeds, "Metallurgical Defects and Their Relation to Service Failures," T. G. Strong, 7 p.m.

Fri., Feb. 16th.—S. WALES GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, "The Manufacture and Performance of Brake Linings," J. G. Remington, 7 p.m.

Institution of Civil Engineers

To-day, Feb. 9th.—YORKSHIRE ASSOCIATION: Church Institute, Albion Street, Hull, "A Main Drainage System Below Sea Level," T. Coates and D. R. Sharp, 6.15 p.m.

Tues., Feb. 13th.—Great George Street, Westminster, S.W.1, "Fundamental Economics in Hydro-Electric Design," C. M. Roberts, 5.30 p.m.

Wed., Feb. 14th.—MIDLANDS ASSOCIATION, JOINT STUDENTS' MEETING: James Watt Memorial Institute, Great Charles Street, Birmingham, "Lighthouses," Dr. Gough, 6 p.m.

Thurs., Feb. 15th.—N.W. ASSOCIATION: Engineers' Club, Albert Square, Manchester, "Britannia Tubular Bridge Over the Menai Straits," J. Cunningham, 6.30 p.m.

Institution of Electrical Engineers

Mon., Feb. 12th.—Savoy Place, Victoria Embankment, W.C.2, Discussion on "Inventor, Engineer and Manager," P. P. Eckersley, 5.30 p.m.——N.E. CENTRE: Neville Hall, Westgate Road, Newcastle-upon-Tyne, "Design of Power Transformers to Withstand Surges Due to Lighting with special reference to a New Type of Winding," A. T. Chadwick, J. M. Ferguson, D. H. Ryder, G. F. Stearn, 6.15 p.m.

Tues., Feb. 13th.—MEASUREMENTS SECTION: Savoy Place, Victoria Embankment, W.C.2, "The Inductor Compass," A. Hine, 5.30 p.m.

Wed., Feb. 14th.—Central Hall, Westminster, S.W.1, "Lamps and Lighting: A Record of Industrial Research," L. J. Davies, 6.30 p.m.——SCOTTISH CENTRE: Heriot-Watt College, Edinburgh, "A New Theory of the Magnetic Amplifier," A. G. Milnes, 7 p.m.——S. MIDLANDS STUDENTS' SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Electronic Motor Control," C. R. Bates, 6.45 p.m.

Thurs., Feb. 15th.—UTILIZATION SECTION: Savoy Place, Victoria Embankment, W.C.2, "The Dimming of Low-Pressure Discharge Lamps," C. E. Williams, 5.30 p.m.

Institution of Engineering Inspection

Tues., Feb. 13th.—COVENTRY BRANCH: Technical College, Coventry, "Electric Welding," F. A. Thomas, 7.30 p.m.

Wed., Feb. 14th.—WOLVERHAMPTON BRANCH: Compton Grange, Wolverhampton, "Latest Methods of Welding," introduced by a film, "Oxygen in Industry," 7.15 p.m.

Institution of Heating and Ventilating Engineers

Tues., Feb. 13th.—S.W. BRANCH: R.W.A. School of Architecture, Bristol, "Town's Gas and the Heating Engineer," T. H. Pardoe, 6.30 p.m.

Wed., Feb. 14th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, Annual General Meeting and Presidential Address, 6 p.m.——LIVERPOOL AND DISTRICT BRANCH: Radiant House, Bold Street, Liverpool, "Space Heating," P. H. Hollingworth, 6.30 p.m.

Thurs., Feb. 15th.—BIRMINGHAM AND DISTRICT BRANCH: Imperial Hotel, Temple Street, Birmingham, "School Heating," J. C. Weston, 6.30 p.m.

Institution of Mechanical Engineers

Mon., Feb. 12th.—DERBY A.D. CENTRE: Midland Hotel, Derby, Annual General Meeting, "The Fell Locomotive," L. F. R. Fell, 7.15 p.m.

Tues., Feb. 13th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, S.W.1, "Wear of Fuel Injection Equipment," A. E. W. Austen and B. E. Goodridge, 5.30 p.m.——S. WALES BRANCH: S. Wales Institute of Engineers, Cardiff, "Thirty Years' Development of Opposed-Piston Propelling Machinery," W. H. Purdie, 6 p.m.——COVENTRY A.D. CENTRE: All-day visit to C.A.V., Ltd., Acton, followed by a visit to Storey's Gate, St. James's Park, S.W.1, "Wear of Fuel Injection Equipment and Filtration of Fuel for Compression-Ignition Engines," A. E. W. Austen and B. E. Goodridge.

Wed., Feb. 14th.—N.W. BRANCH: Liverpool Engineering Society, 24, Dale Street, Liverpool, 2, "Thirty Years' Development of Opposed-Piston Propelling Machinery," W. H. Purdie, 6 p.m.——WESTERN BRANCH: College of Technology, Unity Street, Bristol, 1, "The Full Application of Motion Study," Anne G. Shaw, 7 p.m.

Thurs., Feb. 15th.—E. MIDLANDS BRANCH: School of Art, Green Lane, Derby, "Some Practical Aspects of Power Station Operation," T. Hill, 7 p.m.——MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, "Screws and Screwing," C. Eatough, 6 p.m.——SCOTTISH BRANCH, GRADUATES' SECTION: Royal Technical College, Glasgow, "Grit Removal from Gas Streams," J. M. Wiseman, 6.30 p.m.

Fri., Feb. 16th.—Storey's Gate, St. James's Park, S.W.1, "The Aviation Engine," F. R. Banks, 5.30 p.m.

Institution of Mining and Metallurgy

Thurs., Feb. 15th.—Geological Society, Burlington House, W.1, "Notes on Fire Prevention and Fire Fighting with particular reference to the Kolar Gold Field," H. E. Jeffery; "Filling Stopes with Glacial Drift at Buchans, Newfoundland," Victor Hodgson, 5 p.m.

Institution of Production Engineers

Sat., Feb. 10th.—YORKSHIRE GRADUATE SECTION: Great Northern Station Hotel, Leeds, 1, Film and Discussion on "Use of Ropes," 2.30 p.m.

Mon., Feb. 12th.—SHEFFIELD SECTION: Royal Victoria Station Hotel, Sheffield, "Activities of the Production Engineering Research Association," D. F. Galloway, 6.30 p.m.——DERBY SUB-SECTION: School of Art, Green Lane, Derby, "Generation of Fine Finishes by Machining Techniques," P. Spear, 7 p.m.——HALIFAX SECTION: Whiteley's Cafe, Westgate, Huddersfield, "The Economics of Foundry Mechanisation," J. Blakiston, 7.15 p.m.——LUTON GRADUATE SECTION: Library Lecture Hall, Williamson Street, Luton, Film, "Precision Measurement for Engineers," 7.30 p.m.

Tues., Feb. 13th.—WOLVERHAMPTON GRADUATE SECTION: Wisemore School, Walsall, "Electricity in the Factory," J. S. Brotherton, 7.30 p.m.——YORKSHIRE SECTION: Hotel Metropole, King Street, Leeds, 1, "Industrial Radiography," L. Mullins, 7 p.m.——BIRMINGHAM GRADUATE SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Application of Carbides," 7 p.m.——DUNDEE SECTION: Mathers Hotel, Whitehall Crescent, Dundee, "Payment by Results," A. J. Charnock, 7.30 p.m.

Wed., Feb. 14th.—WESTERN SECTION: Grand Hotel, Broad Street, Bristol, "The History and Development of the Automatic Loom," H. de G. Gaudin, 7.15 p.m.——LIVERPOOL SECTION: Radiant House, Bold Street, Liverpool, "Measurement of Productivity," Walter C. Puckey, 7.15 p.m.——PRESTON SECTION: Clayton, Goodfellow and Co., Ltd., Atlas Iron Works, Park Road, Blackburn, "Ball and Roller Bearings," S. Critchley, 7.15 p.m.

Thurs., Feb. 15th.—GLASGOW SECTION: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Education for Management," Ia. Urwick, 7.30 p.m.——LONDON SECTION: Royal Empire Society, Northumberland Avenue, W.C.2, "Building a Liner," J. S. Redshaw, 7 p.m.

Fri., Feb. 16th.—E. COUNTIES SECTION: Public Library, Ipswich, "Measurement of Productivity," R. G. Hooker, 7.30 p.m.

Institution of the Rubber Industry

Mon., Feb. 12th.—MIDLAND SECTION: James Watt Institute, Great Charles Street, Birmingham, "Some Aspects of Tyre Testing in relation to Vehicle Behaviour," V. E. Gough and P. W. B. Jones, 6.45 p.m.

Institution of Structural Engineers

Tues., Feb. 13th.—WALES AND MONMOUTHSHIRE BRANCH: Mackworth Hotel, Swansea, "Planning Factories for Light Industry," Norman Thomas, 6.30 p.m.

Wed., Feb. 14th.—11, Upper Belgrave Street, London, S.W.1, "The Ultimate Strength of Prestressed Concrete," A. L. L. Baker, 6 p.m.

Thurs., Feb. 15th.—LANCASHIRE AND CHESHIRE BRANCH: Engineers' Club, Albert Square, Manchester, "The Britannia Tubular Bridge Over the Menai Straits," J. Cunningham, 6.30 p.m.

Institution of Works Managers

Tues., Feb. 13th.—WEST MIDLAND BRANCH: Grand Hotel, Birmingham, "The Work of the W. Midlands Joint Electricity Board," W. Lewis, 7 p.m.

Wed., Feb. 14th.—MERSEYSIDE BRANCH: Radiant House, Bold Street, Liverpool, "The Measurement of Productive Efficiency," W. C. Puckey, 6.30 p.m.

Junior Institution of Engineers

Fri., Feb. 16th.—39, Victoria Street, S.W.1, "Modern Practice in the Manufacture of Town Gas," L. J. Clark, 6.30 p.m.

Liverpool Engineering Society

Wed., Feb. 14th.—24, Dale Street, Liverpool, "Thirty Years' Development of Opposed-Piston Propelling Machinery," W. H. Purdie, 6 p.m.

Manchester Association of Engineers

Fri., Feb. 16th.—Engineers' Club, Albert Square, Manchester, "Modern Methods of Painting Machinery and Workshops," S. A. Wood, 6.45 p.m.

Newcomen Society

Wed., Feb. 14th.—Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1, "James White and His 'New Century of Inventions,'" H. W. Dickinson; "Adrian Stephens: Inventor of the Steam Whistle," Charles E. Lee, 5.30 p.m.

Old Centralians

Wed., Feb. 14th.—Chez Auguste Restaurant, Frith Street, W.1, "Some Aspects of Radar," E. Fenessy, 12.55 p.m.

Reinforced Concrete Association

Wed., Feb. 14th.—Institution of Structural Engineers, 11, Upper Belgrave Street, S.W.1, "The Ultimate Strength in Bending of Prestressed Concrete Beams," A. L. L. Baker, 6 p.m.

Royal Aeronautical Society

Tues., Feb. 13th.—4, Hamilton Place, London, W.1, "Derivation and Estimation of Aerodynamic Loads for Stressing Purposes," D. J. Lambert, 7 p.m.

Wed., Feb. 14th.—PRESTON BRANCH: Technical College, Corporation Street, Preston, "Modern Methods of Testing Aero-Engines and Power Plants," A. C. Lovesey, 7.30 p.m.

Thurs., Feb. 15th.—Sibree Hall, Coventry, "Some Aspects of Flight Research," Handel Davies, 7.30 p.m.

Royal Society of Arts

Mon., Feb. 12th.—John Adam Street, Adelphi, W.C.2, "Training for Industry and the Professions," A. G. Beverstock, 6 p.m.

Wed., Feb. 14th.—John Adam Street, Adelphi, W.C.2, "1851–1951: A Century of British Science," D. McKie, 2.30 p.m.

Stoke-on-Trent Association of Engineers

Wed., Feb. 14th.—Midlands Electricity Board, Back Glebe Street, Stoke, "The Manufacture of Steel Tubes," J. S. Blair, 7 p.m.